平成 24 年度 CDM 実現可能性調査　現地調査報告書

調査案件名	染色加工工程の総合的省エネ促進プログラム	ホスト国	バングラデシュ
調査実施団体	株式会社 PEAR カーボンオフセット・イニシアティブ	調査回数	第　1　回

（※現地調査の結果を、下記項目に沿って、2～3 頁程度で報告してください。）

1.　現地調査出張者（外注先などの随伴者がいる場合、そう分かるように記載）：

第一回現地調査の人員構成は、下記のようである。

PEAR:

松尾　直樹

ウテイクル　ゴジャシ

JTCC（日本繊維技術センター）：

森本　国広

東海　恵治

田畑　収

2.　現地調査日程（出発日、宿泊地、帰国日等が分かるようにして、簡潔に記載）：

月日	訪問先
8月31日	成田→ダッカ市内宿泊
9月1日	資料整理、ダッカ着（松尾）
9月2日	午前：現地カウンターパートナー（WST, Grameen Knitwear 及び Landmark）協議。紡績工場燃料消費量、水消費量測定、診断内容、項目の説明と議論。午後：Landmark 工場視察、データ入手ための測定器械設置ポイントのチェック及び関連事項に関する協議。
9月3日	Landmark 工場において、測定、診断の実施。
9月4日	Landmark 工場において、測定、診断の実施。
9月5日	Landmark 工場において、測定、診断の実施。
9月6日	午前：データ整理。午後：Landmark 工場測定、診断結果の発表。
9月7日	資料整理、
9月8日	資料整理
9月9日	Grameen Knitwear 工場において、測定、診断の実施。
9月10日	Grameen Knitwear 工場において、測定、診断の実施。
9月11日	Grameen Knitwear 工場において、測定、診断の実施。
9月12日	Grameen Knitwear 工場において、測定、診断の実施。
9月13日	午前：データ整理。午後：Grameen Knitwear 工場測定、診断結果の発表。
9月14日	ダッカ－バンコク－東京
9月15日	成田着

3.　日程・時間工程別調査内容（現地の訪問先・協議者なども記載）:

月日	業務内容
8 月 31 日(金)	羽田空港ーバンコクーダッカ（ゴジャシ） 関空ーバンコクーダカ（森本、東海、田畑）
9 月 1 日(土)	資料整理（ゴジャシ、森本、東海、田畑） 羽田ーバンコクーダッカ（松尾）
9 月 2 日　(日)	午前:10:30～12:30 訪問先:W.S.T.のオッフィス（ダッカ） 業務内容:Grameen Knitwear, W.S.T. and Landmark との会議。ミッションの説明、関連事項の確認を行った。 参加者: バングラデシュ側:Dr. Engel Wolfram (CEO of W.S.T.) Mr. Ashraful Hassan (Grameen Knitwear Managing Director) Mr. Pradeep Saman (Landmark, General Manager for Knitting) Mr. Shah Alam Dewan (Landmark, General Manager for maintenance) Mr. Anwar Hossain (Grameen Knitwear, General Manager) Mr. Mahbubul Islam (Grameen Knitwear, Dyeing Manager) Miss Tamee Reza (W.S.T., Country Director) Miss Risalatul Ferdous (W.S.T., Management coordinator) その他の方々（参加者名簿を参考に） 日本側:松尾、ゴジャシ、森本、東海、田畑 午後:14:30～17:30 訪問先:Landmark Factory（ダッカ郊外） 業務内容:測定、診断の実施 参加者: バングラデシュ側:Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) 日本側:松尾、ゴジャシ、森本、東海、田畑
9 月 3 日（月）	10:30～17:30 訪問先:Landmark Factory（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam　（W.S.T.）

	日本側：松尾、ゴジャシ、森本、東海、田畑 日本側:松尾、ゴジャシ、森本、東海、田畑
9月4日（火）	10:30〜17:30 訪問先:Landmark Factory（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月5日（水）	10:30〜17:30 訪問先:Landmark Factory（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月6日（木）	午前：データ整理 午後：3:00〜5:00 訪問先:W.S.T.のオッフィス(ダッカ) 業務内容：Landmark 工場測定、診断結果の発表。 参加者： バングラデシュ側:Dr. Engel Wolfram (CEO of W.S.T.) Mr. Ashraful Hassan (Grameen Knitwear Managing Director) Mr. Pradeep Saman (Landmark, General Manager for Knitting) Mr. Shah Alam Dewan (Landmark, General Manager for maintenance) Miss Tamee Reza (W.S.T., Country Director) Miss Risalatul Ferdous (W.S.T., Management coordinator) その他の方々(参加者名簿を参考に) 日本側：松尾、ゴジャシ、森本、東海、田畑
9月7日（金）	資料整理
9月8日（土）	10:30〜17:30 訪問先:Landmark Factory（ダッカ郊外） 業務内容:補足データ収集・測定

	参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.). 日本側：松尾、ゴジャシ、森本、東海、田畑
9 月 9 日（日）	10:30～17:30 訪問先：Grameen Knitwear（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9 月 11 日（月）	10:30～17:30 訪問先：Grameen Knitwear（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9 月 12 日（火）	10:30～17:30 訪問先：Grameen Knitwear（ダッカ郊外） 業務内容:測定、診断の実施 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam (W.S.T.) 日本側：松尾、ゴジャシ、森本、東海、田畑
9 月 13 日（水）	午前：資料整理 午後：3:00～5:00 訪問先:W.S.T.のオッフィス(ダッカ) 業務内容:Landmark 工場測定、診断結果の発表。 参加者: バングラデシュ側:Dr. Engel Wolfram (CEO of W.S.T.) Mr. Ashraful Hassan (Grameen Knitwear Managing Director) Mr. Pradeep Saman (Landmark, General Manager for

	Knitting) Mr. Shah Alam Dewan (Landmark, General Manager for maintenance) Mr. Anwar Hossain (Grameen Knitwear, General Manager) Mr. Mahbubul Islam (Grameen Knitwear, Dyeing Manager) Miss Tamee Reza (W.S.T., Country Director) Miss Risalatul Ferdous (W.S.T., Management coordinator) その他の方々（参加者名簿を参考に） 日本側：松尾、ゴジャシ、森本、東海、田畑
9 月 14 日（木）	ダッカ～バンコク～成田　（松尾、ゴジャシ） ダッカ～バンコク～関空　（森本、東海、田畑）
9 月 15 日（）	成田着（松尾、ゴジャシ） 関空着（森本、東海、田畑）

4.　調査結果概要

（1）　バングラデシュの紡績工場における染色過程の現状の確認ができた。

今回の二つの紡績工場での調査結果から見ると染色機における電力消費量は、染色過程の電力消費量の約30％、蒸気の消費量は、約95％であることが判明でき、染色機における染色手法の改善を対象とする本PoA で技術の省エネ効果に関しての確信ができた。今回の測定・診断の報告書は作成中である。

（2）　ベースライン設定及びモニタリングの関連事項の検討と確認ができた。

ベースラインの決定のためのバッチごとのエネルギー（電力、蒸気）消費量の実績の把握可能性についての確認ができ、色 × 材料の組み合わせごとにエネルギー消費量の実績データを収集することになった。

モニタリングが必要となる染色機における電力及び蒸気消費量に関して、現実を踏まえ、電力消費量を直接測定する一方、専門家との検討によって蒸気消費量を、染色機における染色実績のグラフによって計算することにした。

（3）　今後の事項に関する確認と合意ができた。

今後の予定事項（利害関係者会議、有効審査）などについて、合意ができた。例えば、10月での利害関係者会議の開催、11月での有効審査の開始、12月での有効審査現地調査などで現地パートナーとの合意ができた。

5.　特筆すべき問題点（プロジェクトの実現可能性に係る大きな問題が発見された、調査業務の進行を妨げる大きな問題が生じた等）

特になし

6.　その他の課題（「特筆すべき問題点」よりも軽微であるが事業化に向けて翌月以降の調査で解決すべき課題、調査方針の変更など）

（1） 染色機における染色過程の実績のグラフの収集と管理

（2） グリッド或はキャプティブ発電者の CO_2 排出係数の把握

（3） PoA-DD 及び CPA-DDs の作成

調査案件名	染色加工工程の総合的省エネ促進プログラム	ホスト国	バングラデシュ
調査実施団体	株式会社 PEAR カーボンオフセット･イニシアティブ	調査回数	第　2　回

1. 現地調査出張者:
   第 2 回現地調査の人員構成は、下記のようである。
   PEAR: ウテイクル　ゴジャシ

2. 現地調査日程(出発日、宿泊地、帰国日等が分かるようにして、簡潔に記載):

月日	訪問先
11 月 3 日	羽田～バンコク～ダッカ(ダッカ市内宿泊)
11 月 4 日	現地カウンターパートナー(W.S.T, Grameen Knitwear 及び Landmark)協議。利害関係者会議の準備条状況の確認。
11 月 5 日	利害関係者会議
11月 6 日	会議結果の整理、W.S.T と今後の予定、関連事項及びデータなどについての協議
11 月 7 日	ダッカ～バンコク
11 月 8 日	成田着

3. 日程･時間工程別調査内容(現地の訪問先･協議者なども記載):

月日	業務内容
11 月 3 日(土)	羽田空港－バンコク－ダッカ
11 月 4 日(日)	午前:10:30～13:30 訪問先:W.S.T.のオッフィス(ダッカ) 業務内容:会議準備状況の確認及び染色機メーカーからの専門家と染色過程における水･蒸気消費量の計算方法について協議。 参加者: バングラデシュ側:Mr. Herman Freericks (Thies) Mr. Thomas Mende (Thies) Mr. Kauser Bhuiyan (W.S.T) Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) 日本側:ゴジャシ 午後:14:30~17:30 訪問先:会議場 業務内容:会議場の確認 参加者:

	バングラデシュ側:Mr. Arman Islam (W.S.T.) Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) その他の W.S.T 及び Grameen Knitwear と Landmark の代表 日本側:ゴジャシ
11 月 5 日 (月)	午前:10:30〜13:00 訪問先:Lotus Hall, Uttara Club, Dhaka 業務内容:利害関係者会議へ参加 参加者: バングラデシュ側:Vice president of Bangladesh Garment Manufacturers and Exporters Association (BGMEA) Grameen Knitwear and Landmark の代表 そのたの紡績工場代表者 染色機メーカー代表者 など50名以上 日本側:ゴジャシ
11 月 6 日（火）	10：30〜17：30 訪問先:W.S.T.のオッフィス（ダッカ） 業務内容:会議の結果の整備及び今後の予定確認 参加者： バングラデシュ側：Miss Risalatul Ferdous (W.S.T.) Mr. Suvro Dev Saha (W.S.T.) Mr. Arman Islam （W.S.T.） 日本側：ゴジャシ
11 月 7 日（火）	ダッカ〜バンコク
11 月 8 日（木）	成田着

4. 調査結果概要

（1） 利害関係者会議へ参加

参加者の意見、コメントを収集でき、ドラフト PoA-DD の完成できました。

（2） 専門家と染色機における水・蒸気の消費量の計算方法（染色過程グラフに基づいて）に関して議論を行い、意見及び指導を受けることができました。すなわち、現在の計算方法では、問題ないそうですが、専門家からより詳細な計算方法を提供して頂くことになりました。

（3） 今後の事項に関する確認と合意ができた。

今後の予定事項（有効審査の現地調査の予定）などについて、合意ができた。例えば、11 月での有効審査の開始、1月のはじめに有効審査現地調査などで現地パートナーとの合意ができました。

また、11月中にバングラデシュの紡績工場での染色方法におけるコモンプラクティスを示すために、質問票形式サーベイ実施することで合意できました。

5. 特筆すべき問題点（プロジェクトの実現可能性に係る大きな問題が発見された、調査業務の進行を妨げる大きな問題が生じた等）

特になし

6. その他の課題（「特筆すべき問題点」よりも軽微であるが事業化に向けて翌月以降の調査で解決すべき課題、調査方針の変更など）

（1） CPA-DDs の作成に必要となるデータ及び情報の入手。

調査案件名	染色加工工程の総合的省エネ促進プログラム	ホスト国	バングラデシュ
調査実施団体	株式会社 PEAR カーボンオフセット･イニシアティブ	調査回数	第　3　回

1. 現地調査出張者:
第2回現地調査の人員構成は、下記のようである。
PEAR: 直樹　松尾
　　　ウテイクル　ゴジャシ
JQA: 暁子　古屋
　　　宏　小林

2. 現地調査日程(出発日、宿泊地、帰国日等が分かるようにして、簡潔に記載):

月日	訪問先
1月5日	羽田～バンコク～ダッカ(ダッカ市内宿泊) W.S.Tと打ち合わせ。
1月6日	Grameen Knitwear 工場への訪問
1月7日	電力供給会社United Power Generation and Distribution CompanyLtd.と水供給システム（Water Supply System）を視察
1月8日	Japan Textile Products Quality and Technology Center (QTEC) Dhaka Lab を訪問また染色剤、薬品を生産者(Dystar、Clariant (Bangladesh) Ltd）代表と面談。
1月9日	Landmark Factory及びBangladesh GarmentManufacturers & Exporters Association (BGMEA)を訪問
1月10日	午前：Closing meeting 午後：ダッカ～バンコク～成田
1月11日	成田着

3. 日程･時間工程別調査内容(現地の訪問先･協議者なども記載):

月日	業務内容
1月5日(土)	羽田空港ーバンコクーダッカ
1月6日(日)	午前:9:00～16:30 訪問先:Grameen Knitwear 工場(ダッカ郊外) 業務内容:CPA1 の対象である工場の事情確認とデータ収集 参加者: バングラデシュ側:Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.)

	Mr. Suvro Dev Saha (W.S.T.) Grameen Knitwear 工場関連スタッフ 日本側:松尾、ゴジャシ、古屋、小林
1月7日 (月)	午前:9:00～12:00 訪問先:United Power Generation and Distribution Company Ltd. 業務内容:排出係数のための燃料消費量及び発電量データの確認 参加者: バングラデシュ側:Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) Grameen Knitwear 工場関連スタッフ 日本側:松尾、ゴジャシ、古屋、小林 午後:13:00～17:00 訪問先:DEPZ Water Supply System及びDEPZ Central Effluent Treatment System 業務内容:水供給システム(ポンプなど)の運営状況と関連データの確認 参加者: バングラデシュ側:Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) Grameen Knitwear 工場関連スタッフ 日本側:松尾、ゴジャシ、古屋、小林
1月８日(火)	９:００～１１:30 訪問先:W.S.T.での染色剤、薬品生産者代表の面談 業務内容:各染色過程における染色剤、薬品などに関する情報の確認 参加者: バングラデシュ側:Dystar、Clariant (Bangladesh) Ltd) の代表者 午後:13:00～15:00 訪問先:Japan Textile Products Quality and Technology Center (QTEC) Dhaka La 業務内容:プロジェクトに対して、専門家的な意見の収集。 参加者: バングラデシュ側: Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) (QTEC)の専門家 日本側:松尾、ゴジャシ、古屋、小林
1月９日(火)	９:００～１１:30 訪問先:Bangladesh Garment Manufacturers & Exporters Association (BGMEA) 業務内容:バングラデシュ紡績業界事情などの確認

	参加者： バングラデシュ側： Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) BGMEA の関連スタッフ 午後:13:00～17:00 訪問先:Landmark Factory 業務内容:今後の CPA の対象となる工場の事情確認 参加者： バングラデシュ側： Mr. Milinda (W.S.T) Mr. Arman Islam (W.S.T.) 工場関連スタッフ 日本側:松尾、ゴジャシ、古屋、小林
１月１０日（木） １月１１日（金）	９：００～11：００ 訪問先:W.S.Tオフィス 業務内容:Closing meeting 午後：ダッカ空港 ダッカ～バンコク～成田 成田着

4. 調査結果概要

（1） 有効審査の現地調査が予定とおりに実施できた。

1月5日～10日にわたって、DOE が現地を行い、PoA-DD への改善の指摘を行った。

（2） 指摘項目における改善及び今後の予定についての合意ができた。

i、 ベースラインのおける染色技術のチャートの決定において、既存の記録データをベースに最も保守的なチャート（染色リシピ）を再確認する。

ii、 ボイラからのCO_2排出係数を計算するために、保守的ボイラのスペック数値を用いる。

iii、 ポンプの効率（kwh/m^3水）の計算のために、井戸の深さとポンプのスペック数値を用いる。

iv、 Micro scale CDM のルールで CPA の追加性の論証を行う（W.S.T と試算の結果、殆どの工場において省エネルギー量は、micro scale の閾値以下でことは判明）。

v、 モニタリングについて、電力は、各染色機に電力計を設置して測定する。水と蒸気の量について、携帯式蒸気流量計、水流量計で、サンプルで測定を行う。 これに関して、SSC WG から以前提出した確認事項についての電話会議の要請があり、1月11日に17:30（日本時間）に電話会議が行われた。そこ結果、a. 方法論でのエネルギーの直接測定という記述は、蒸気量また温度などの測定から熱エネルギーを計算すると解釈できるということの確認ができた。AMS-I.D また AMS-II.K におけるモニタリング要件を参考できるということでした。 b. 染色機における蒸気の量に対して、実測することには難度があることなら、保守性に保障できるような実績チャートから読み取る方法を提案することも可能であるという確認ができた。 この結果を踏まえて、W.S.T との相談の上、上述したような携帯式の蒸気流量計を用い、サンプル手法で

モニタルングを行うことで、DOE とも合意した。

5. 特筆すべき問題点（プロジェクトの実現可能性に係る大きな問題が発見された、調査業務の進行を妨げる大きな問題が生じた等）

特になし

6. その他の課題（「特筆すべき問題点」よりも軽微であるが事業化に向けて翌月以降の調査で解決すべき課題、調査方針の変更など）
（1） ベースラインの設定（ベースラインにおける技術のチャートの再確認）の調整。

BANGLADESH TEXTILE FACTORY SURVEY REPORT IN THE FIELD OF ENERGY & WATER SAVING

Issued by Japan Textile Consultant' Center

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I n d e x

Appendix

1. General concept of JTCC Activity

- Our JTCC survey, there have been efforts to excavation projects eligible for CDM shown below, in the business survey commissioned by PEAR Carbon Offset Initiative Corporation to assisting that JTCC has worked as a project overseas technical supporting
- From the viewpoint of preventing global warming, reducing the amount of carbon dioxide emissions is the urgent issue that was imposed on the nation, in every region on earth. Intergovernmental Panel on Climate Change of the United Nations in the year 1999 (Intergovernmental Panel on Climate Change, abbreviation: IPCC), based on the arrangements for the United Nations Framework Convention on 3rd World meteorological environment was held in Kyoto. It is the so-called Kyoto Protocol. This developed countries will count in suppressing the generation amount of their own, the amount of reduction of carbon dioxide in the bill in developed countries, and reduce emissions, by applying to developing countries energy-saving technology possessed by the developed countries, was thus obtained terms of being able to have been resolved. (Clean Development Mechanism = CDM)
- In view of the cases CDM above, water and energy in the department dyeing textile factories of two consisted with knitting, dyeing,
  and sewing where have been near Dhaka, the capital of the country Bangladesh (northern 30km from the center) was intended to measure the content consumption figure mainly in natural gas, electricity and steam in the processing equipment and facilities. And in some portion by visual data, we would give suggestions for improvement for energy and water saving.
  To understand the overall condition of the site inspection, normally we are doing prior survey to the target sites..
  However this time, we could not preliminary survey due to various reasons. We have developed a research plan with reference to the prior report from the company; such as Water Saving Technology Ltd is an organization that has implemented the project of environmental issues mainly water conservation in the textile dye-houses.

2. Energy and water-saving goals and research overview of Bangladesh dye houses

2-1. Background

- ◆ Textile dyeing and finishing industry (Hereinafter referred to as the dyeing industry) is the energy intensive industries as well as water, the process is different for every company, there is hardly any difference there such a thing as a benchmark of equipment and procedures, and water and energy consumption.
- ◆ Steam is applied to physicochemical some processes, which are scouring & bleaching so call preparation, and dyeing.
- ◆ And another heat energy which is getting by burning indirect or direct from coal, heavy oil, gas, biomass, etc..
- ◆ In case of steam, There is a case that receives the supply of the external or rely on the supply from the boiler of their own. Although the boiler pressure is less than 1 MPa, for a large load variation from the conditions of use that the changes are made frequently, followed by coal and biomass is difficult to load variation, tend to be too large for the consumption situation is. Electrical energy is used as the driving force of the rotating body and the pump drive these processing devices, such as a fan.
- ◆ For water, most of the dyeing and other steps are performed as a medium of water; soft water is used for washing and rinsing. Large variation of materials and equipment, such as lot size by its consumption, there is a continuous process and batch methods as treatment, and less consumption is a continuous process in general. However, batch processing-intensive are forced to exist in the future may not be able to adapt to the continuous process by the material.
- ◆ Therefore, energy and water conservation in the dyeing industry should be set up the own target which is most appropriate for your organization. And goal effort as a whole factory, the perception is particularly difficult.

  To set the target for each equipment in the individual steps, and the whole together in the company or association, it sets the priority for target achievement like investment of money, goods and personnel.

2-2.Basic countermeasure for energy & water saving in Dye-houses

- ◆ Energy & water monitoring equipment for each machine should be given the opportunity for saving , if in case of no monitoring , saving chance have nothing in every industry. This is because you cannot set the target value of energy and water-saving if there is no monitoring of the individual facility.
- ◆ What is the necessary monitoring equipment?

  (1) Steam flow meter,

  (2) Electric power meter,

  (3) Gas or other heating medium flow meter or weigh system.

  Saving water is a water flow meter. These data output today has become possible, a recording unit of time, total daily dose is possible easily. Recording device temperature history of dyeing equipment, instruction set and the temperature and humidity of stenter and dryer has become mandatory as recorded in the other course. In recent dyeing apparatus control program is especially common sense; it has become the mechanism that will be memory in the recording medium and after dyeing procedural, it can be output from the dyeing machine actual figures were also based on the instructions of the program.
- ◆ As reference data when the dyeing result is abnormal case than the energy saving purpose, which is equipped with means to ensure the normal operation of the dyeing machine side.
- ◆ It is a ranking of the following energy saving if dyeing, and start with the big ones of the effect at low cost.

(1) It is keeping heat and insulation.

To prevent the dissipation of thermal insulation material without the use of naked pipes and processing equipment temperatures higher than 30 ℃ than normal room temperature.

(2) Waste heat recovery is 2nd important means. The heat energy contains in the exhaust dye liquors and drying machines, etc.

(3) Thermal energy recovery device and the drain heat exchanger should be installed in proper places.

It will be 30% of energy saving can be achieved in this part thoroughly.

Remodeling process and equipment, it is necessary to mobilize the intellect.

Make improvements in terms of energy saving and devices from the traditional process, the most important point in this case is serious consideration to quality. It is one way of the energy saving technique that decreases the energy intensity by improving productivity.

(4) Making and organizational mechanism to centralize the management of energy and water as a result of the above improvements can be validated by the corporate site is necessary. And cost balance is an important task of the utility department, their main target are efficient operation of boilers, drainage and maintenance of reference heat and water facilities.

3. Factories' evaluation of investigation

◆ Factories which have been surveyed this time, it is a leading company in Bangladesh dyeing factory; we can also guess that HP and company size. Looking at it from that you have referred to as water-saving dispatching guidance (WST) and the Ambassador of Water Saving Technology Ltd is also the coordinator of the survey; the higher the priority of the two factories is expected in particular.

◆ Technical support team also JTCC, energy and water-saving technique for investigation has been mastered from the experience in India, Indonesia, and China. As walk through mission is performed prior to the actual research usually, inevitably face the site without rehearsal this time, I had a hard time in the selection of measurement equipment.

◆ Two plants in Bangladesh are in a state of almost untouched to the extent that has worked on some of the condensed vapor recovery activities on energy conservation has not been done, utility manager has a little interest in them.

◆ It is scandalous not done well in boilers, the fuel consumption and the water supply is a particularly important figure. It has not been carried out because WST is also contained in the guidance water consumption, but it would not have been grasped by the measuring instrument or the like. Any kind subjected to saving energy and monitoring has not been granted. Measuring instrument is not equipped with any expression, but also all gas direct heating to stenter and dryer which are consumed a lot of energy in the dyeing factory.

◆ Dyeing machines have standard program control device manufactured by Sedex. The dyeing program has been structured to be set in each of the machine following the production order sheet together with fabrics. And the memory card can be sucked up the feedback data of temperature history in dye bath, but data management dyeing feedback has not been carried out with both plants.

◆ Subject to this survey is different, "color matching" is also big theme The important dyeing companies are (Color matching).

◆ Most have not been used but has introduced a system of Datacolor Inc (USA). With the department dyeing, one company had been also utilized light source device standard incidental thereto, another company has to check the sample dyeing under fluorescent lights of the room, and this is extremely problematic also there.

◆ To check the dyed color by the light source in the standard measures is essential for right color matters.

◆ Knitting → dyeing → Sawing procedure has been carried out in the same location, two plants which have been surveyed; the situation is very favorable in terms of logistics and QR (Quick Response Production). So final garment product can get immediately after dyeing and finishing.

◆ Sample making is always needed short production term. Here sample product can get within a few days after product planning. as a business system is a huge advantage It takes a month at least in Japan for sample making.

◆ At LFL, water pipe and steam line are much complicate, so it is very difficult to look for the final places in consumption.

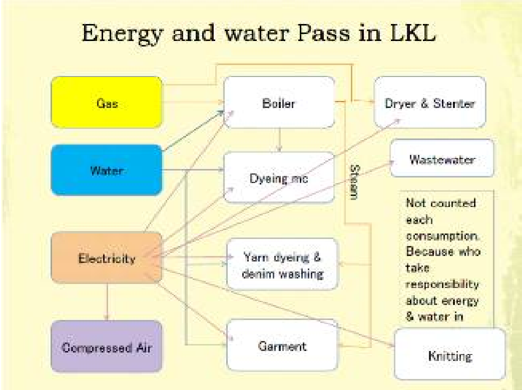


Figure 3-1 Energy & water supply network in LFL

4. Countermeasures for energy & water saving in BGD

As above mentioned, two factories have no monitoring system or measurement tools. All the data that is to give some guidance to those factories should be collected within short terms.

And even taken the data there, but those are only one time or few hours record, therefore figures are not always exact, may be.

Please read over our countermeasures after understanding our situation.

4-1 Energy saving from Dyeing process (Utilization of cooling water)

Two factories have carried on dyeing by High-pressure Jet dyeing machine which are round type. Dyeing materials are 100% knitted fabrics that are produced by them and some are bought from other parties.

As mentioned above chapter, both factories not well managed warmed cooling water.

LTL has sent cooling water to main soft water pit, and GKL has sent to boiler after mixed with condensed water. Warmed cooling water have to keep in isolated tank nearby dyeing machine, and apply to dyeing or hot rinsing, so both factories can be saved 25% steam saving.

4-1-1 Composition of dyeing materials

Material composition is very important factor to investigate energy and water consumption in dye-houses. About this, we got information from W.S.T about GKL, but not LFL

GKL's rate is as follows,

Table 4-1Mmaterial occupation rate for dyeing in GKL from W.S.T report

Materials	CVC	Cotton	Polyester
Rate	10%	60%	30%

And for cotton or CVC, reactive & direct dyes are occupied 50:50 (estimation). However analysis makes more difficulty to finalize, therefore cotton dyeing has made 2 groups as follows,

Table 4-2 Dyeing program in each material and its statistical group to simplify

Materials	CVC	Cotton		Polyester
Dyes combination	Disperse +Reactive	Reactive	Direct	Disperse
Rate	10%	30%	30%	30%

According to LFL' composition is not clear, so our calculation is used Table 1 as components. Naturally dyeing materials in occupation is changed quite big amount depending on seasons, fashion trends and market condition.

Therefore material composition is difficult to fix in the factories which are dyeing many type of materials. (In Japan, Thailand and Indonesia, dyeing materials are fixed in each dye-house. China is same style as BGD)

4-1-2. combination dyeing and white color

In case of CVC, two kinds of dyes are used normally, but sometimes only one side (cotton or polyester) is dyeing. Our calculation is based on both side dyeing. And white is one kind of dyeing particularly for polyester.

And our calculation is based on medium color. In case of light color (included white) is less energy and water about 20%, and heavy color is more 20%. That reasons are retention time of dyeing process, but also hot and cold rinsing times are more and less.

4-1-3. Dyeing program

In modern dyeing system or machine dyeing method is fundamentally different from handmade craft; especially dyeing process is carried on automatic systems.

Therefore modern dyeing machine is adopted computerized system to achieve "right color" batch by batch in best way.

Dyeing program is based on color matching particularly less chance for re-dyeing.

Every dye-house always wants to improve the dyeing program, and every dye-house use individual dyes and machine combination, therefore dyeing program is different each other. In case of combination dyeing, the program should become more complicate.

For two investigation factories, W.S.T gave us each factories dyeing program.

We think that is their standard or common programs, so our suggestions follow by those programs and for your reference, we put on our standard too.

4-1-4.Energy and water demand quantity from dyeing program (calculation shown by excel sheet by Excel file)

To estimate the energy and water consumption in dyeing process, we must set up assumption.

Table 4-3 Model scheme for general condition in dyeing in BGD

Property	Requirement	Property	Requirement
Fabrics	CVC,Cotton,PET	Dye bath ratio	1:8 or 1:6
Machine	HP JET	Carry over	150 to 250%
Fabric weight	1500kg/batch	Water temp	30℃→40℃
Fabric weight	150kg/batch	Cooling water	30℃→27℃
Dyes for PET	Disperse	Washing or Rinsing	No overflow (Step by step system)
Dyes for Cotton	Reactive or Direct		
Dyes for CVC	Disperse +Reactive		

Table:4-4 One sample from Excel sheet for energy and water saving calculation

Theoretical Culuculation For Water & Energy Consumption in Dyehouses in BG

Machine weght	4000	kg	Carry over →	Cotton	250
Fabric weight	1500	kg		CVC	200
Water ratio	8	:1		Polyester	150

Put the figure on yellow area you want and check operation tim

Cotton	Carry Over →	250		Hot water ℃	40	Fresh water ℃	27	End point at cooling (℃)	80	Heatchanger efficiency(%)	80
	Operation times	Materials	Weight(kg or liter)	Heat s.p	Setting T.	Temp.up from 40℃	Kcal(by steam)	Subtotal (kcal)	Cooled energy	Kcal(from dye bath)	Cooling water
PE Dyeing	0	machine	0	0.114	130	90	0		0		
		fabric	0	0.32	130	90	0		0		
		water	0	1	130	90	0	0	0	0	0
Scouring	1	machine	4,000	0.114	105	65	29,640		11,400		
		fabric	1,500	0.32	105	65	31,200		12,000		
		water	12,000	1	105	65	780,000	840,840	300,000	323,400	5,925
Hot wash	2	machine	8,000	0.114	95	55	50,160		13,680		
		fabric	3,000	0.32	95	55	52,800		14,400		
		water	16,500	1	95	55	907,500	1,010,460	247,500	275,580	5,466
Enzime	1	machine	4,000	0.114	80	40	18,240		0		
		fabric	1,500	0.32	80	40	19,200		0		
		water	8,250	1	80	40	330,000	367,440	0	0	0
Dyeing R	1	machine	8,000	0.114	60	20	18,240				
		fabric	1,500	0.32	60	20	9,600				
		water	8,250	1	60	20	165,000	192,840		0	0
Cold wash	5	machine	20,000	0.114	45	5	11,400				
		fabric	7,500	0.32	45	5	12,000				
		water	41,250	1	45	5	206,250	229,650			
Acid wash	1	machine	8,000	0.114	45	5	4,560				0
		fabric	1,500	0.32	45	5	2,400				
		water	8,250	1	45	5	41,250	48,210			
		Subtotal water	94,500				Sub total energy(kcal)	2,689,440		Sub T (liter)	11,391

Heat radiation during each process		Body area(m2)	72.61	Diameter m	2.5	
				Length m	8.0	
Air temp	35		Radiation Factor=10kcal/m2·hr·℃		Radiation Heat	Sub-total kcal
	Minute	SurfaceTemp				
Poly Dyeing	0	80	10		0	
Scouring	40	68	10		15,975	
Hot wash	60	60	10		18,153	
Enzime	40	50	10		7,261	
Reactive D	200	50	10		36,306	
					Heat Radiation	77,695

Steam entalpy	498.8kcal/kg/6kg-abs
Condenced entalpy	100.0kcak/kg/1kg

Total kcal	2,767,135
Steam/condenced ton	5.55
water (m3)	94.50
Cooling water(m3)	11.39
Unit Consumption	1kg fabric
Steam/condenced(kg)	3.70
water (liter)	63.00
Cooling water(liter)	7.59

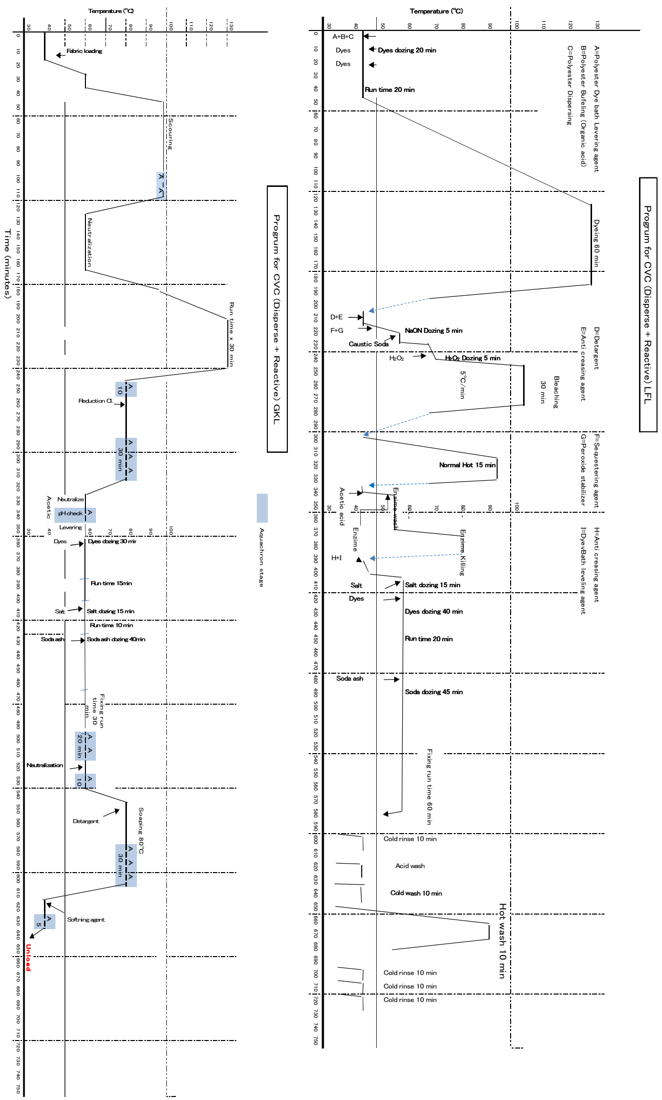


Figure:4-5. Dyeing program for CVC in both factories

Table:4-1. Final result in saving of steam & cooling water in dyeing process (estimation from dyeing program)

	For one batch			Per one kg Fabric			
	Fresh water	30℃	Cooling water	30℃	Fabric weight(kg	1500	
FONG'S 4	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	10.33	111.00	27.66	6.9	74.0	18.4	1:8
Cotton(Reactive)	7.67	94.50	11.96	5.1	63.0	8.0	1:8
Cotton(Direct)	7.54	78.00	21.43	5.0	52.0	14.3	1:8
Polyester	7.81	60.75	27.51	5.2	40.5	18.3	1:8
	Fresh water	30℃	Cooling water	30℃	Fabric weight(kg	150	
THIES 1	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	0.85	7.50	2.19	5.7	50.0	14.6	1:6
Cotton(Reactive)	0.83	9.45	1.27	5.6	63.0	8.5	1:8
Cotton(Direct)	0.85	7.80	2.34	5.7	52.0	15.6	1:8
Polyester	0.67	4.28	2.20	4.5	28.5	14.7	1:6

	Fresh water	40℃	Cooling water	27℃	Fabric weight(kg	1500	
FONG'S 4	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	7.88	111.00	26.39	5.3	74.0	17.6	1:8
Cotton(Reactive)	5.55	94.50	11.39	3.7	63.0	7.6	1:8
Cotton(Direct)	5.46	78.00	20.35	3.6	52.0	13.6	1:8
Polyester	6.48	60.75	26.26	4.3	40.5	17.5	1:8
	60.75	40℃	Cooling water	27℃	Fabric weight(kg	150	
THIES 1	26.258163	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	0.66	7.50	2.08	4.4	50.0	13.9	1:6
Cotton(Reactive)	0.60	9.45	1.21	4.0	63.0	8.1	1:8
Cotton(Direct)	0.66	7.80	2.22	4.4	52.0	14.8	1:8
Polyester	0.56	4.28	2.10	3.8	28.5	14.0	1:6

	For one batch			Per one kg Fabric			
Fabric Wt:1500kg	Fresh water Temp.chenge 30→40℃		Cooling water Temp. change 30→27℃				
FONG'S 4	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	▲ 23.7	0.0	▲ 4.6	▲ 23.7	0.0	▲ 4.6	1:8
Cotton(Reactive)	▲ 27.6	0.0	▲ 4.8	▲ 27.6	0.0	▲ 4.8	1:8
Cotton(Direct)	▲ 27.6	0.0	▲ 5.0	▲ 27.6	0.0	▲ 5.0	1:8
Polyester	▲ 17.0	0.0	▲ 4.6	▲ 17.0	0.0	▲ 4.6	1:8
Fabric wt.150kg	Fresh water Temp.chenge 30→40℃		Cooling water Temp. change 30→27℃				
THIES 1	Steam t	Water m3	Cooling W	Steam kg	Water L	Cooling W	Bath ratio
CVC	▲ 22.3	0.0	▲ 4.6	▲ 22.3	0.0	▲ 4.6	1:6
Cotton(Reactive)	▲ 27.6	0.0	▲ 4.8	▲ 27.6	0.0	▲ 4.8	1:8
Cotton(Direct)	▲ 22.3	0.0	▲ 5.0	▲ 22.3	0.0	▲ 5.0	1:8
Polyester	▲ 15.7	0.0	▲ 4.6	▲ 15.7	0.0	▲ 4.6	1:6

For both factories, we try to calculation to four kinds of material follow with dyeing program. We get result as below.
Warmed cooling water should be kept in proper tank or pit, then use it process directly.

4-1-5. Saving amount and some paradox between calculation & actual

It is very easy to understand that water and heat energy saving is done by utilization of warmed cooling water from Jet dyeing machines.

By estimate, almost 25% steam and 5% cooling water can be saved by warmed cooling water management.

When we made calculation to save water & steam, we made **Table4-7.** At the same time, we have analyzed experimental data for both factories water and steam supply.

Table:4-7 Estimated water & steam consumption in dyeing process in both factories

	Landmark Fabrics Ltd				Grameen Knit wear Ltd			
Materials	CVC	Cotton(R)	Cotton(D)	Poly100%	CVC	Cotton(R)	Cotton(D)	Poly100%
Production rate	10	30	30	30	15	30	30	25
Total Production/day			15.0	ton			10.0	ton
Water consumption/ton	92.4	71.0	66.3	58.8	92.4	71.0	66.3	58.8
Total Water Consumption each item/day	138.6	319.5	298.4	264.6	138.6	213.0	198.9	147.0
Total water/day	1,021.1				697.5			
Actual Consumption/day	2,400.0 *1		(1,080.0) informed		1,150.0 *2		(992) informed	
Difference from calculation	235.1% (105.8%)				164.9% (142.2%)			
Total Steam Consumption/ton	6.9	5.1	5.0	5.2	6.9	5.1	5.0	5.2
Total Steam Consumption each item/day	10.4	23.0	22.5	23.4	10.4	15.3	15.0	13.0
Total Steam consumption/day	79.2				53.7			
Actual Consumption/day	306.0 *3 (50% steam for Dyeing)				113.0 *4			
Difference from calculation	189.3%				210.6%			

Total: By calculation from dyeing program
Actual consumption (water & steam *1,* 2,* 3,* 4): From data collection by measurement.
Informed: received figure from W.S.T (LFL), from company accountant (GKL)

* Landmark factories have two pipelines and supply water many area in factories.
Left side to boiler in LFL (No.1 Pipe)　　　　Right side to boiler in LFL(No.2 Pipe)

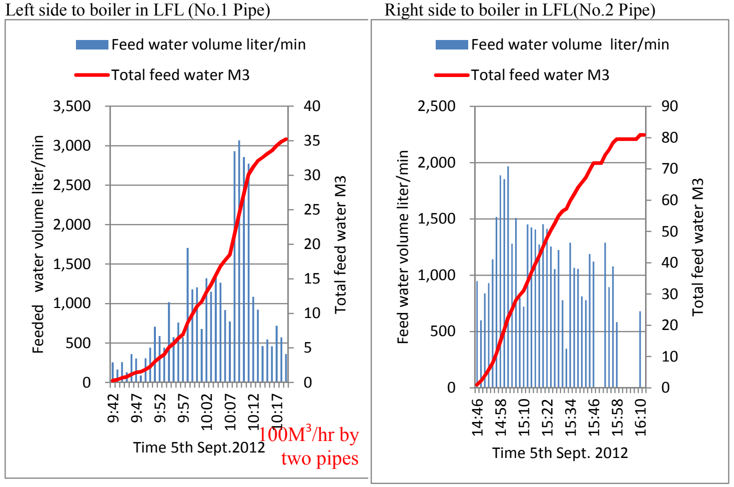


Figure: **4-2** Water volume to supply all factories except boilers in LFL(prompt data)

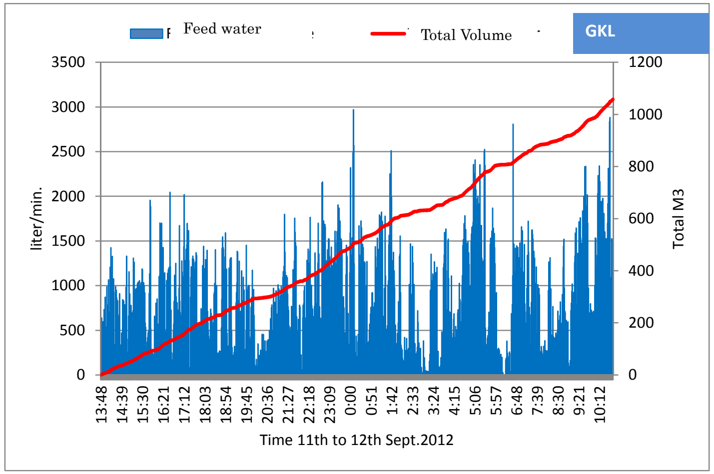


Figure: **4-3** Water volume supplied to dyeing &finishing in GKL (whole day data)

From **Table 4-7**, we can find some question, because value differences from total one and actual consumption.
According to calculation, we don't include other section's consummation (boiler water, lab works, office and finishing section), and some extra works at dyeing section itself; re-dyeing, machine cleaning and toilet)

Particularly LFL's pipe line for water & steam is very complicated. They have another two or three factories, like hunk dyeing, denim washing and sewing thread dyeing.
Therefore above figure have contained its consumption as well.
More detail of steam supply is shown **Table 4-14**.

Table 4-8 water saving amount by cooling water management

Cooling water consumption & Reducing amount liter/kg-fabric

			Landmark		Grameen	
Material	Dyeing W	Cooling W	Rate	Share	Rate	Share
CVC	74	18.4	10	1.84	15	2.76
C (React)	63	8	30	2.40	30	2.40
C (Direct)	52	14.3	30	4.29	30	4.29
PET	40.5	18.3	30	5.49	25	4.58
Average			Av.water	14.02	Av.water	14.03
Production/day		ton		15		10
Water for Cooling		m3		210		140
Saving amount (rate 5%)		m3		11		7

Table:4-9 Saving steam quantity from warmed cooling water

	Landmark Fab.	Grameen knit
Total steam consumption/day-ton	79.2	53.7
Saving rate	25%	25%
Saving amount/day-ton･steam	19.8	13.4
Saving amount/ton-steam/year	5,940	4,020
Saving energy/year	16,260GJ	11,000GJ
Cost saving/year (Tk)	3,200,000	2,180,000

0.4MPa-steam:2,738kJ/kg, 1m3gas:14.7kg-steam, 1ton-steam=544Tk

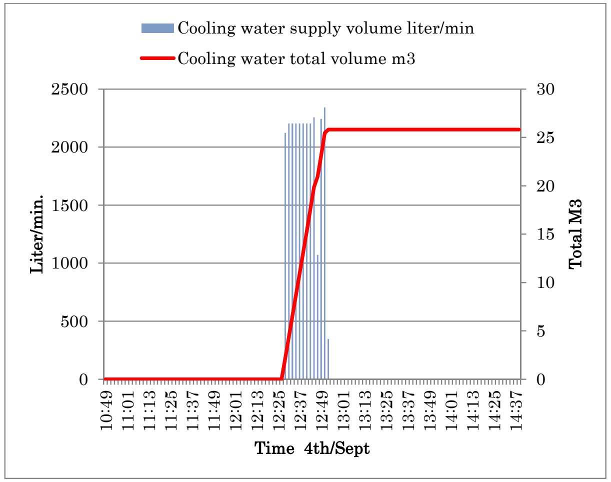


Figure: 4-4 Cooling water supply condition Fong's 1500kg Dyeing machine

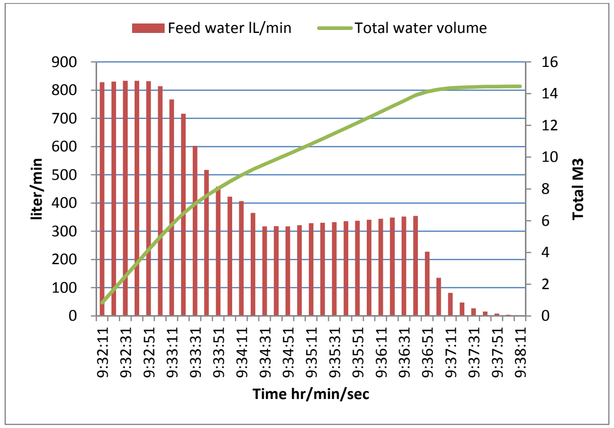


Figure: 4-5 Cooling water supplies for Japanese dyeing machine PIV controlled (reference)

◆ Cooling water supply condition must be pay attention, sudden water is not well effect, particularly at intermediate of cooling process, water supply should be reduced its volume to make efficiency increase.

4-2. Heat recovery from dye-bath wastewater

Dyeing process is used hot water in dye-bath. After finish each step, dye-bath water is exhausted time by time.

Those exhausted drain is go to wastewater treatment plant without any heat recovery in BGD.

To take back heat energy from waste is primitive technology for energy saving.

By our experiment to waste from dye-bath, temperature peak is shown in reference figures

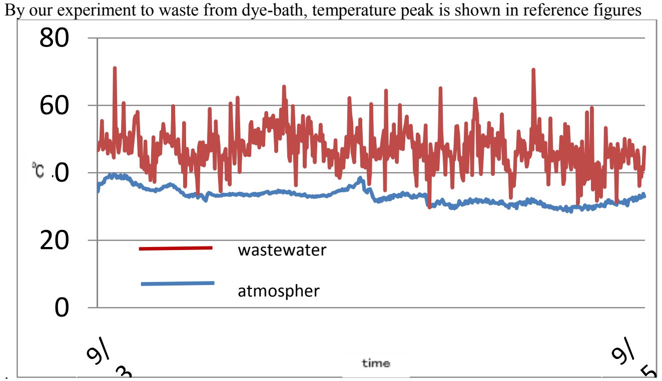


Figure:4-6 dyeing machines (Thies No.5) wastewater temperature in LFL

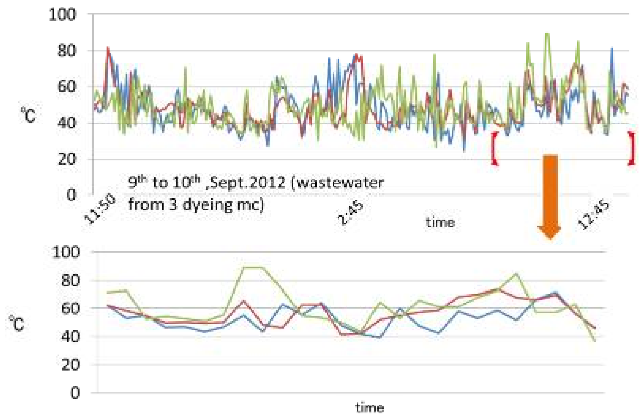


Figure:4-7 3 dyeing machines wastewater temperature in GKL

Table:4-10 Hot wastewater volume from dye-bath

	CVC		Cotton(Reactive)		Cotton(Direct)		Polyester	
1500kg fabrics	Volume (Liter)	Setting Temp.	Volume (Liter)	Setting Temp.	Volume (Liter)	Setting Temp.	Volume (Liter)	Setting Temp.
Dyeing	9,000	130			9,000	95	9,000	130
Scouring	9,000	105	9,000	105	9,000	105		
Hot wash	18,000	95	18,000	95	18,000	95	9,000	95
Enzime	9,000	80	9,000	80	9,000	80		
Total water	45,000	75	36,000	75	45,000	75	18,000	75
		30%		30%		30%		10%
	13,500		10,800		13,500		1,800	
Average/rate for 1500kg-fabric			39,600 liter/1,500kg-fabric					
Average liter/kg-fabric			26.4 liter/kg-fabric					

Supposing to collect all waste heat from dye-bath, and thermal exchange by exchanger, the next value can be saved

Table 4-11 Energy saving value by heat exchanger from wastewater

	Landmark Fabric Ltd	Grameen Knit wear Ltd
Production ton/day	15	10
Wastewater volume	26.4m3x15tons=396m3	26.4m3 x 10tons=264m3
Outlet Temp. from heat exchanger	75℃-15℃=60℃	75℃-15℃=60℃
Heat recovery energy/day	(60℃-30℃) x 396m3=11,880Mcal	(60℃-30℃) x 264m3=7,920Mcal
Eq.steam quantity/day	11,880Mcal/650kcal=18.2ton	7,920Mcal/650kcal=12.2ton
Energy saving rate *1	18.2t/79.2t=23%	12.2t/53.7t=23%
Energy saving rate *2	18.2t/306t =6.0%	12.2t/113t=10.8%
Energy saving/year	3,564Gcal=14,922GJ	2,376Gcal=9,931GJ
Cost saving/year (Tk)	18.2ton x 300 x 544=3,000,000	12.2ton x 300 x 544=2,000,000

*1: Saving rate is based on dyeing energy by idealized figures
*2: Saving rate is based on all energy consumed at the moment.

4-3. Heat recovery by insulation for dyeing machine

High temperature dyeing machine is radiating quite big heat energy during one by third in dyeing time.

Long tube type dyeing machine which is used in Asia area is insulated in common.

But in hot country, insulation has been neglected. And round type is quite difficult to insulation. We try to calculate if possibly have done insulation.

Table: 4-12 Dyeing machine surface insulation effect for energy saving

Landmark Fabric				Grameen Knit			
m/c No.	Diameter mm	Length mm	Area(M^2)	m/c No.	Diameter mm	Length mm	Area(M^2)
T1	2,350	2,280	25.49	Athena	2,400	5,134	47.73
T2	2,300	4,200	38.64	AT-4	1,500	4,000	22.37
T3	2,300	4,200	38.64	HT-3	1,500	3,700	20.96
T4	2,300	4,200	38.64	HT-1	1,500	1,900	12.48
T5	2,300	4,200	38.64	HT-4	1,500	3,700	20.96
T6	2,300	4,300	39.36				
F1	2,300	3,500	33.58				
F2	2,300	4,200	38.64				
F3	2,300	4,330	39.58				
F4	2,400	8,000	69.33				
Total(M^2)			400.53	Total(M^2)			124.51

	Landmark Fabric		Grameen Knit	
Average Surface Temp	70	℃	70	℃
Atmosphere Temp.	30		30	
Higher temperature time	8	hrs	8	hrs
H.Radiation rate (kcal/hr/℃/m2)	10		10	
H.Radiation rate by insulation (kcal/hr/℃/m2)	2		2	
Energy saving effect (Mcal/day)	1,025(1.57t-steam)		319(0.49t-steam)	
Energy saving /year (GJ/year)	1,285GJ		400GJ	
Saving cost (Tk)/year	1.57 x 300 x 544=256,000		0.49 x 300 x 544=80,000	

4-4 Electric consumption in Dyeing machine

◆ Electric power energy are used for fabric transportation by winch wheel and Jet water circulation pomp in dyeing machine.
Drum type dyeing machine which have been improved in Europe is first experience for us to investigation.
In Japan and many south Asia countries, long tube type dyeing machine is common.
In case of long tube, we never saw more than 500kg-fabric load. And in case of 500kg-fabric load, main motor capacity to circulate fabric & water is 55kW, and operation load 25kW.
In the other hand, drum type machine electric power is very small, even 1500kg-fabric Sclavos is consumed 13.5kW. Supposing long tube type Jet machine is operated as same load, electric power should be needed 6 times of Drum type one.
As well as inverter speed controller is adopted too, electric energy has been able to reduce more.
We have learned that drum type dyeing m/c is much energy saving than our tube type dyeing machine.
It means that for dyeing machine it is less energy saving potential.

Table 4-13 Dyeing machine operation power

11th Sept. 11:00～

Machin No	Item	Total Power			Main		Main Moter			Load Rate
		kW	hP	A	A	kW	A	kW	HZ	%
AHT-4	1st	39.54	53	85	22.5	13.25	21.0	12.37	41.4	
	2st				26.5	15.61	25.0	14.72	41.4	
	3st				20.0	11.78	18.0	10.60		
	Av					13.54		12.56		34.25
HT-3	1st	23.5	31.5	42	16.6	9.78	13	7.66	45.9	
	2st				13.8	8.13	12	7.07	45.9	
	3st				13.8	8.13	12	7.07	45.9	
	Av					8.68		7.26	45.90	36.92
HT-1	1st	13.43	18	27	7.3	4.30	6.5	3.83	46.5	
	2st				5	2.94	4.3	2.53	46.5	
	3st				6	3.53	5	2.94	46.5	
	Av					3.59		3.10		26.75
AT-4	1st	26.86	36	54						
	2st									
	3st				16	9.42	13.4	7.89	45.6	
	Av					9.42		7.89		35.07
HT-4	1st	24.62	38	84	18.5	10.89	15.2	8.95	45.9	
	2st				16.2	9.54	14.2	8.36	45.9	
	3st				16	9.42	13.4	7.89	45.9	
	Av					9.95		8.40	45.9	40.42

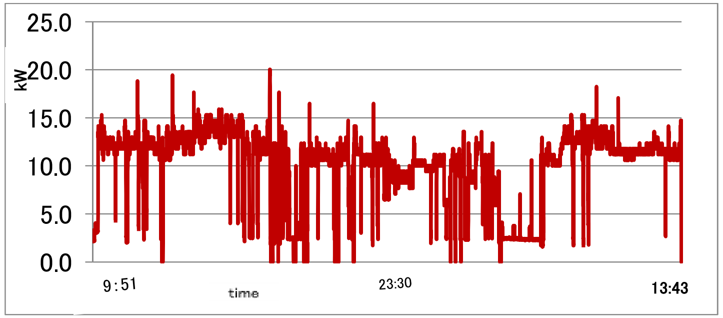


Figure 4-8 Dyeing machine pomp motor loads (Fong's No.4 in LFL)

- In both factory, all dyeing machines are controlled by inverter system, but speed reduction is only the beginning and ending time, and during dyeing operation, fabric speed is not varied linked with dyeing programs.

4-5.Stenter & Dryer

- Usually when we are going energy investigation in dye-houses. The first target is stenter, because this machine consumes a lot heat and electric energy in every dye-house.
  The first step in research is look over the fuel consumption record, and electric power record.
  After checking both record and monitor gauge, we investigate operation condition.
- At both factories, they have no monitoring instrument, and consumption record.
  Natural gas is main heating fuels for dryer and stenter, and direct burning system.
  We have nothing to catch up devises for gas consumption.
  And both factories' machine is stopping very often, therefore we gave up to take thermal data collection.

- All stenter have been very poor maintenance.
  In dye-house, stenter speed or operation efficiency is covered with total production capacity.
  Therefore stenter must be kept the best condition in all over days.
- Circulation fans for one chamber are broken in GKL Turkey made stenter , and some burner trouble in LFL Germany stenter.
- Pinning operation is basic function on stenter, but in both stenter, some pin sheets have serious brake. Broken pin-sheets should be changed immediately, otherwise machine productivity go down seriously.
- What is reason to stop machine very often, this stenter has interlocked with fan motors, so when every operation stop caused, fan motors stopping, therefore chambers inside is no hot air circulation. Very often machine stop make very lower efficiency and lower production.
  Machine speed has some tolerance by checking taco-meter.
  Within one hour, how many times stenter stop? **(Figure 4-9,10)**
- Some doors' packing became loose, then hot air leaking. Dryer has soaked cool air from lint filter space.
- LED monitoring device have worn out, so indicated figure cannot see clearly.

Table 4-16 Stenter motors condition ALKAN (Tarky made)

	Item	Rating output	Measurement value			Power factor	Output	Load factor
			Voltage	Ampere	Frequency		Calculated value	
		kW	V	A	Hz	%	kW	%
1	Main chain drive Motor	7.5	399	8.6	42	85	5.1	67
2	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	8.5	42	85	5.0	33
3	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	9.6	42	85	5.6	38
4	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	8.5	42	85	5.0	33
5	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	8.3	42	85	4.9	33
6	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	399	9.4	42	85	5.5	37
7	Cabin Blower Drive Motor-2Pcsx7.5 kw	15.0	-	-	-	-	-	Stop
8	Exhaust Fan Drive motor	7.5	399	5.7	24	85	3.3	45
9	Padder Roller Drive Motor - 1Pcsx11 kw	11.0	399	8.4	16	85	4.9	45
10	Padder Roller Drive Motor - 1Pcsx11 kw	11.0	399	5.0	14	85	2.9	27
11	Infeed Upper Roller Drive Motor	4.0	399	2.7	14	85	1.6	40
12	In feed Lower Roller Drive Motor	4.0	399	2.4	12	85	1.4	35
13	Others Load	49.4	399	6.3	-	85	3.7	7
	Total	184.4	399	83.4	-	-	49.0	27


Stenter & stenter burner in LFL


Stenter (Tarky) and Dryer burner in GKL

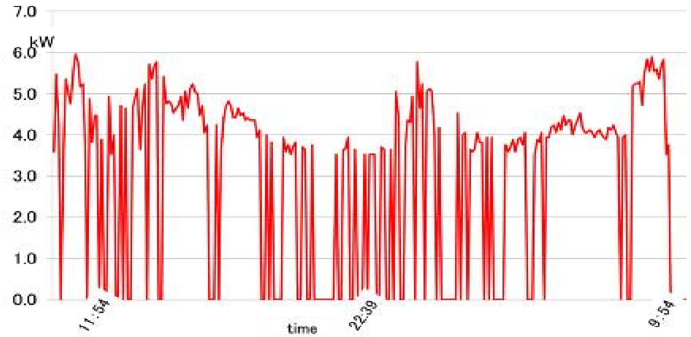


Figure 4-9 Stenter main motors operation LKL

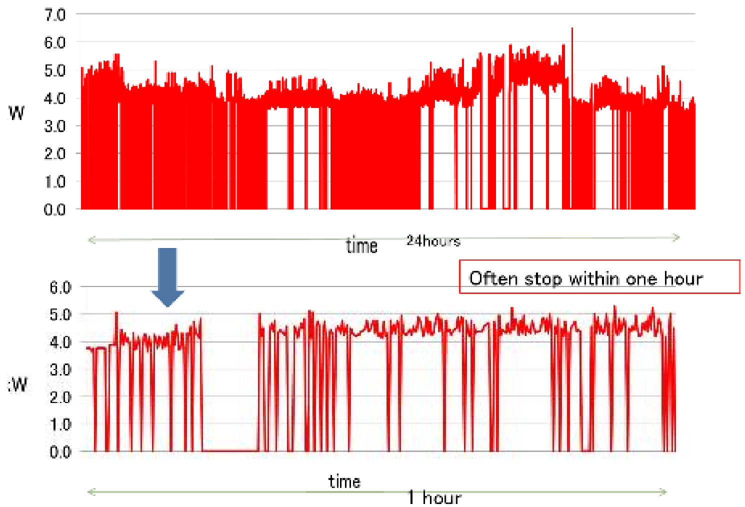


Figure 4-10 Stenter main motors operation (GKL)

4-6 Washing off effect

- Washing process need more water and energy. Dyestuffs selection is one point to reduce them.
- Direct dyes are one selection, because dye- liquor is not much contamination as reactive dyes.
- Aquachron rinsing is suitable for polyester 100%, but for cotton need plenty water. For reactive dyes, batch style rinsing can reduce water and energy.

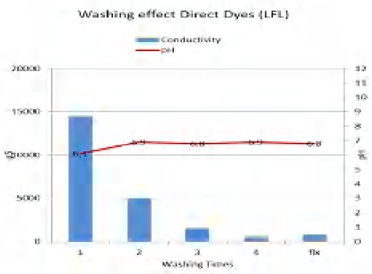


Figure 4-11 Washing effect by Direct Dyes

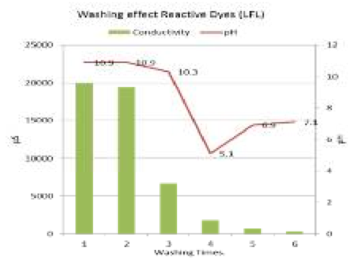


Figure 4-12 Washing effect by Reactive Dyes

Figure 4-13 Wastewaters from rinsing bath (LFL)

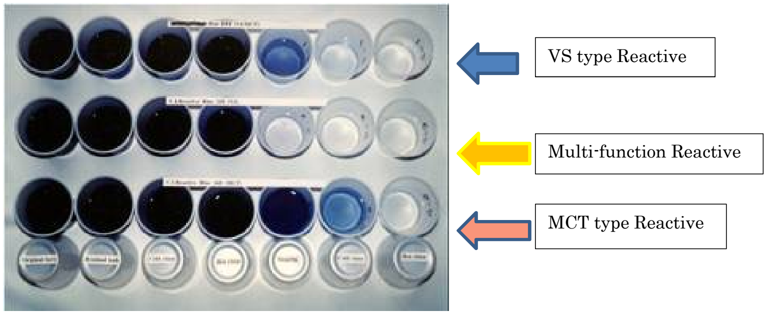


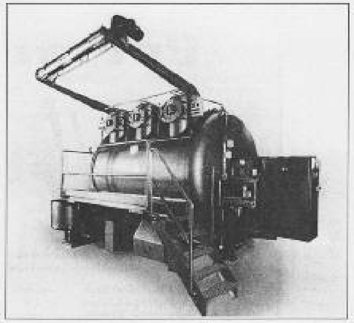
Figure 4-14 washing off comparison (for reference)

記事連番0021

Sclavos: AquaChron Dye Rinsing System

As jet dyeing technology has evolved over the last 20 years, much focus has been placed on lowering liquor volume during processing to improve the dyeing parameters. Liquor ratios have been lowered from 20:1—30:1 in the early days to 5:1 or lower today. These changes have produced cost benefits in dyeing but at the expense of making dyeing more difficult and rinsing much more inefficient and time-consuming. When you consider that, with reactive dyes, 70% of the processing time, 80% of utilities and 90% of the water used is during rinsing, it is obvious that this is a great expense for the dyehouse and an area of needed improvement.

By: Sclavos SA



AquaChron improves efficiencies and reduces time, water and utilities up to 50% compared to conventional jet technology

Recognizing this, Sclavos SA developed the AquaChron rinsing system in its new Venus dye machine. AquaChron is a revolutionary water/time management system that has resulted in a dramatic increase in rinsing efficiency over conventional dyeing technology.

AquaChron, uses the Twin Soft Flow nozzle system. As most rinsing occurs at the jet nozzle, two soft-flow jets in tandem yield an increased intensive zone. By combining these two nozzles with an elbow pipe, this critical intensive zone is enlarged to provide more than eight time the area of contact over that of conventional machines.

For this reason alone, fabric has more contact points with the liquor. When rinsing, fabric leaves this area cleaner with each pass. At the same time, liquor exits in a more contaminated state. Use of the Twin Soft Flow also has boosted fabric quality. Moving away from liquor pressure at the nozzle to liquor volume to move the fabric eliminates many problems such as pilling, creases and rope marks. This improvement occurs in all fabric categories, from plain knits and wovens to more difficult fabrics such as those with stretch properties.

The next development centers on

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Textile Machinery Technology

a main drawback of rinsing in conventional jets, where the cleaned fabric and dirty liquor exit the jet and follow the same path to the bottom of the machine. Dirty liquor must actually filter through the fabric to pass to the drain, thereby redepositing on the fabric. Sclavos has overcome this problem by using a liquor by-pass system that removes contaminated liquor from the machine directly after the nozzles, thus avoiding inefficiencies normally experienced in other machines.

By developing a more sophisticated level of control, new approach is to have a complete dye cycle where the dye machine bath is never dropped of filled. The end result of using AquaChron is improved efficiencies and up to 50% reduction in time, water and utilities over conventional jet technology. An additional benefit is better fabric quality that can be achieved in dyeing in shorter dye cycles and avoiding stopping that fabric.

When you consider that dyeing represents the greatest expense in the dyeing and finishing operation, such savings produce a substantial cost advantage over conventional machines.

As the textile business becomes more competitive, AquaChron represents an opportunity for the customer to realize the benefit of lower production costs and increased productivity. ❑

(Circle 349 on reader service card)

記事0022

(Refer from Textile world USA; April 1998)　Copy by Japan Science & Technology Agency

4-7 Dyestuffs and chemicals

Our investigation is not subject for “Right color first time”, but some serious maters we can point out.

◆ Dyestuff storage

Weigh of dyestuffs is very important for right color, but sometimes people not concentrate the place where dyes are kept properly. The main point is how to prevent from moisture content and how to prevent humans’ health from dyestuffs dust.

You may understand easily that a fresh dyestuff which is taken from new packing is keeping for few days in atmospheric condition; weight of dyestuffs is different before and after.

Most of dyes can soak moisture about 10% in high humidity countries.

Therefor after open the package of dyes, it must keep some container to prevent from moisture and circumstance must keep cool & dry.

Sometimes we can see working people make cleaning water splash floor in dyestuffs room.

It is prohibited to splash water on floor of dyestuffs storage area.

◆ Common salt

Two factories in BGD, as common salt, sodium sulphate crystalized (Glaber salt) is adopted, but it is quite difficult to solve in water particularly in case of big amount, after put in dosing tank, it must keep long time to perfect solving. To make easy and correct method is making concentrated solution (50%) in other area, and send it to machine side by pomp.

Chemical preparation time can make shorter and achieve right color.

Dyestuffs keeping properly

Floor cleaning prohibit using water, needed ventilation system

5. Energy conservation in utility section (Landmark fabric ltd.)

5-1 Steam condensate recovery

◆ In case of heat up substances, mainly latent heat in steam gives it function. After heating steam condensate is flush out from steam traps. Condensate has no latent heat, but still have sensible heat more less 100℃。

◆ Condensed drainage is not only useful for heat energy, but also water souse.

◆ The recovery system of condensed water is two ways. One is open system and other is closed one. Open system is going under atmosphere condition and closed system is under pressured condition.

◆ In case of open system, maximum temperature of condensed is 100℃, but investment is quite lower. On the other hand, closed system can be get condensed water in higher temperature. Therefore, closed system has advantage in the efficiency of recovering.

◆ For condensed recovery in LFL, open system is recommendable, and already they have start new pipe installation.

Under the moment situation, expected result will be shown below,

Heat energy reserving: water evaporation= 306ton/day (by measurement of boiler water), Recovery rate:85%, Steam drain temperature:90℃

306ton/day×0.85×(90℃-40℃）=13,000Mcal/day 13,000Mcal/306t=42℃

54.36GJ/day×300day/year=16,308GJ/year (Energy saving/a)

Boiler feed water temperature will be reach to 80℃, if condensed drain will be used only for boiler water, don’t mixe to dyeing feed water tank.

Table: 5-1 Steam feeding pipe line from 3boilers

Pipe section area			Operation time	Steam		Steam use
inch	mm	cm2	hrs.	ton/hr.	ton/day	
6	150	177				Boiler inlet
6	150	177				Boiler inlet
4	100	79				Boiler inlet
Total		432		14.2		
1	25	5	24	0.08	2.0	Feed tank
2	50	20	10	0.33	3.3	Accessories Factory
4	100	79	24	1.32	31.8	Washing plant
3	75	44	10	0.74	7.4	Garments iron
3	75	44	10	0.74	7.4	Sweater iron
3	75	44	10	0.74	7.4	Sweater iron
4	100	79	24	1.32	31.8	Dyeing (Jet)
6	150	177	24	2.98	71.5	Dyeing (Jet)
6	150	177	24	2.98	71.5	Yarn dyeing
6	150	177	24	2.98	71.5	Fong's dyeing
Total	-	839	-	14.2	306	

5-2 Exhaust heat recovery from boiler chimney

◆ According to boiler efficiency, exhaust air from boiler chimney must keep in mind.

To make higher efficiency in boiler, the most interesting matters are heat recovery from chimney air.

◆ Boiler attendant put on record about boiler condition in quite often.

Table 5-2 is copied from record, No.1 boiler was shown as214℃, No.2 boiler was 213℃. As it was high degree, so heat recovery has made the efficiency higher.

◆ Heat recovery amount from exhaust air is shown as below;

Theoretical air volume for boiler combustion: A0

Theoretical exhaust air volume for boiler combustion: Go

Those parameters are introduced “*Boie*” formula.
HL: Feverish value by joule unit
A0 and G0 are introduced following calculation.
Ao=(2.957×HL/10,000)-3.91＝2.957×41,800/10,000-3.91＝10.57Nm3/m3
Go=(3.763×HL/10,000)-3.91＝3.763×41,800/10,000-3.91＝11.29Nm3/m3
Actual volume of exhaust=Go+（m-1）×Ao＝11.29+（1.4-1）×Ao＝11.29+（1.4-1）×1057＝15.52Nm3/m3
m : oxygen content rate→oxygen content before burning in air/oxygen content after burning in exhaust air →almost 1.4 (is ideal figure)
Fuel amount for burning(G)×Specific heat of exhaust air×（exhaust air temp - exhaust air temperature after transfer heat energy）＝15.52×998×1.38×（214-120）＝2,009,228kJ/hr（480,676kcal/hr）: 47m3 natural gas equivalent
Total annual energy saving =2,009MJ/hr×24hr×300day/a/1,000,000=14,466GJ/a

Table: 5-2 Chimney temperature record in boiler

Recording date 9/1						
time	Boiler No.1			Boiler No.2		
	chimney	steam	water	Chimney	steam	water
3	220	9.0	48	212	8.5	45
4	215	8.5	47	215	8.5	42
5	212	8.0	45	213	9.0	45
6	210	9.0	45	212	9.0	43
7	220	8.5	43	210	8.5	45
8	215	9.0	43	215	8.0	40
9	212	8.5	42	215	8.0	42
10	210	8.5	42	213	8.5	45
Av	214	8.6	44	213	8.5	43

Recording date 9/2			
time	Boiler No.1		
	Chimney	steam	water
7	215	8.0	45
8	212	9.0	45
9	213	8.5	42
10	215	8.5	47
11	215	9.0	45
12	212	8.0	42
13	215	8.0	42
14	212	7.5	45
Av	214	8.3	44

5-3. Heat recovery from gas engine generators.

Table 5-3 daily record on gas engine generator

item	unit	Generater1 (1030kW)	Generater2 (1145kW)	Generater2 (1145kW)
Date and time	–	9/4 13:50	9/3 16:19	9/4 15:20
Voltage	V	400	405	405
Ampere	A	913	1457	1436
Power factor	pf	0.82	0.794	0.805
Out put	kW	511	813	812
Frequency	Hz	–	49.9	50.08
exhaust gas	℃	505	561	561
gas header	Nm3h/h	–	227	227
Fuel use rate1	kWh/Nm3	–	3.58	3.58
Fuel use rate2	Nm3/kWh	–	0.279	0.280

◆ **Table 5-3** is shown the temperature of exhaust air from gas engine generators.
◆ Exhaust air temperature from gas engine generators is very high.
By their record generator No.1 is 505℃, and No.2 is 561℃。Therefore it is recommended to install the steam boiler by heat recovery type.
Off course, steam from them can be used in the factory.
◆ Heat recovery is shown as follows,
Theoretical air volume for boiler combustion: A0

Theoretical exhaust air volume for boiler combustion: Go
Those parameters are introduced “*Boie*” formula.

Ao=2.957×HL/10,000-3.91＝2.957×41,800++/1,0000-3.91＝10.57Nm3/m3
Go=3.763×HL/10,000-3.91＝3.763×41,800/10,000-3.91＝11.29Nm3/m3
Actual gas volume of exhaustion is below (G)
G=Go+（m-1）×Ao＝11.29+（2.0-1）×Ao＝11.29+（2.0-1）×1057＝32.43Nm3/m3

(1) Be able to recovery energy from Generator No.1
(Actual exhaust gas volume) x (electric power by generator) x (fuel consumption) x (specific energy of exhaust gas) x (temperature difference before and after
32.43×399×0.279×1.38×（505-200）＝1,519,508kJ/hr（363,518kcal/hr）
(2) Be able to recovery energy from Generator No.2
32.43×578×0.279×1.38×（561-200）＝2,605,345kJ/hr（623,288kcal/hr）
(1)+(2)=1,519,508kJ/hr+2,605,345kJ/hr＝4,124,853kJ/hr（986,807kcal/hr）
For one year: operation efficiency=70%
4,124,853kJ/hr×0.7 ×24hr×300day/year/1000,000=20,789GJ/a

5-4 Thermal insulation for steam line

◆ There are many facilities without thermal insulation in boiler room and dyeing section; i.e. Steam pipes, valves and flange. Without thermal insulation protect heat losses, reducing boiler loading and electric power consumption.
◆ Even heat insulated have done, but already used quite long period, insulation material have worn out, it is better to change them periodically.
◆ Thermal loss without insulation on flanges and pipes at boiler site is shown in **Table 5-4**

Table 5-4 Steam loss from non-insulation or leaking valves

Valve size	Heat radiation from surface of steam valve		Valve	Amount of steam leak
	MJ/set･hr	MJ/set･day	sets	MJ/day
50A	16.1	386	5	1,931
80A	26.7	641	5	3,205
100A	34.8	836	5	4,178
150A	59.4	1,427	3	4,280
200A	87.2	2,092	3	6,275
total			21	19,869

◆ As 21-sets of valve are non-insulated, total 19,869MJ energy are diffused for one day. and annual amount as below,
19,869MJ/day×300day/year/1,000=5961GJ/year

5-5 Steam trap maintenance

Steam traps are installed at the end of steam line to prevent loosing energy. Steam traps have some kinds to matching for its purpose. However steam traps are running always with main facilities and those are not looked after properly. Supposing non maintenance for steam traps, steam leaking should be happened. And caused by leaking, energy loosing will be increased seriously.
◆ There are two reasons for steam leaking from steam traps.
1st reason is damaged steam trap itself without maintenance,
2nd reason is that some steam is splashed out with condensed water by mechanical reasons.

If steam amount is quite much, in that case it must change, because traps' construction or size is not suitable in steam facility.
By the reasons of non-maintenance, leaked steam amount is shown in **Table 5-5**

Table 5-5 Steam loosing amount depending on leaking condition

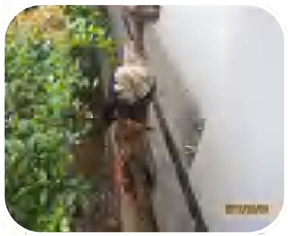
Item	Amount of lost steam			No of traps	Total amount
	kg/hr/set	kg/day/set	MJ/day/set	sets	MJ/day
1. leaks out a little__	4	96	263	5	1,314
2. leaks out a middle	7	168	460	5	2,300
3. leaks out a lot___	15	360	986	10	9,857
Total				20	13,471

- One sample is shown above **Table**.**5-5** Supposing 20 pieces traps are damaged, energy loosing is 13,471MJ/day. Otherwise, steam lost in amount is13,471MJ/day×300day/year/1,000=4,041GJ/year
- Some pictures are taken in LFL as follows,

main pipe condence extraction

From dyeing machine

Main pipe



From condensed pipe

Figure 5-1 Condensed and steam leaking in many places

5-6 Improvement of boiler efficiency

- LFL has 3boilers and they have used gas for fuels. Only one boiler (No.3) has gas and water flow meter. We measured both flow meters promptly. Data is shown **Table** 4-18.
- The boiler efficiency of No.3 is 79%, and it is not bad, but conductivity and hardness of boiler water are quite higher, boiler inside should be contained with some scale we have suspected.
- To improve the boiler water management, boiler efficiency should be improved more less 3%.
  Steam evaporation weight: 4.57m^3
  Gas consumption per hour: 360m^3
  Specific Enthalpy per kg-steam: 2,768kJ=661kcal (under 8 bar),
  Specific Enthalpy per kg-water:167kJ=40kcal(40℃ water)
  Gas combustion energy per m^3: 41,800kJ=10,000kcal
  Moment boiler efficiency＝
  4,570kg/h×(2768kJ/kg-167kJ/kg)/(360m^3/h×41,800kJ/m^3)×100=79%
  In case of boiler efficiency improved 79%⇒81%
  358m^3/hr-（358m^3/h/81%×79%）=9m^3/hr（9m^3/hr×41,800kJ /m^3＝376.200kJ/hr
  376.200kJ/hr×24hr×300day/year/1,000,000=<u>2,709GJ/year</u>

Table 5-6 Boiler No.3 efficiency measurement

Measuring date 5th.Sept. 17:40～17:50

time	Gas consumption		steam
	m3/mim	m3/hr	ton/hr
17:41	6.1	-	-
17:42	5.8	-	-
17:43	5.9	-	-
17:44	6.1	-	-
17:45	6.0	-	-
17:46	6.0	-	-
17:47	5.8	-	-
17:48	6.1	-	-
17:49	5.9	-	-
17:50	6.0	-	-
total	59.7	358	4.57
10 mins.	5.97m3/min		Water flow

Table 5-7 Measurement of boiler supply and internal water condition

Measuring date 5th .Sept. 10:00

		Water Softener (Ion exchange)		Boiler Water
		Inlet	Outlet	
Boiler 1	Temp	30.7	30.8	
	Hardness	5 0～100	0～10	0～10
	μ s	224	233	1,792
Boiler 2	Temp	30.7	30.8	
	Hardness	5 0～100	0～10	0～10
	μ s	224	233	4,924
Boiler 3	Temp	30.5	30.8	-
	Hardness	5 0～100	0～10	10
	μ s	234	281	9,105

Blow down frequency: every 1min/hour

5-7 Electric power saving in wastewater treatment plant (WTP)

- WTP is adopted in activated sludge method, and 2 sets of air blower are supplied air for aerobic bacteria. Those blower motors have not variable speed systems.
- For activated sludge system, dissolved oxygen amount (DO) is very important parameter to keep condition steady always.
  By our DO measurement, oxygen concentration has been maintained within 3.1 to 6.2 ppm as shown in **Table 5-8.**
  By the regulation of BGD, DO value must be more than 5.0 ppm, but excess than 5.5ppm is meaning of waste of electric power.
- To reduce air supply to aeration tank, it is some methods. (1) Cut air supply to close the air valve. (2) Change pulley diameter to slow down blower rotation. (3) Install inverter controller to change rotation speed. The system (3) can be reduced electric power.

Table 5-8 DO condition in WTP (LFL)

Item	DO ppm	Temp ℃
Inlet drain	0.73	42
Equalization tank		
Reach chamber		
Primary setting tank (Fresh mixer tank)	3.1	40.4
Primary setting tank	3.5	
Drain		
Aeration tank	6.0	35.4
Drain		
Secondary setting tank	6.2	35.9
Recover tank		
Filter		
Outlet drain		

Table 5-9 WTP condition

Parameter	In put	Out put
BOD	82	48.6
COD	290	128
TDS	4210	1760
DO	0.0	4.6
pH	10.67	7.51

Copy from BGD the authority report

6. Energy conservation in utility section (Grameen knit wear Ltd.)

6-1. Efficiency improvement in boilers' load

- For boiler operation, load factor is very important.
  In case of lower load in boiler, as heat radiation rate become higher, so total energy efficiency will be going down. The other hand, boiler load is higher, exhaust air contain more sensible heat, fuel energy may diaper to atmosphere, therefore total efficiency will be go down also.
  Therefore boiler operation is needed reasonable load rate, so as 60% to 80% of full capacity is recommended shown as **Figure 4-7**

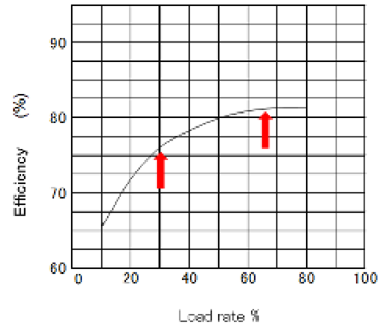


Figure: 6-1 boiler efficiency and load relation

- The speculation load of Boiler No.2 is 4,535kg/hour; however actual operation is only 1,400kg/hour, consequently is not well in efficiency.
  From Figures, boiler efficient rate is 76% automatically.
- Our recommendation is that three boilers are reduced to two boilers operation (Boiler No.3 is stop). Therefore efficiency of boiler No.2 is improved as mentioned below,
  Boiler No.2 load rate; 5,630kg/（3,630kg+4,535kg） x 100=68%
  Boiler No.2 efficiency; 81% from Figure (5% up)
  By calculation, following energy saving can be achieved;
  (1400kg/hr-(1400kg/hr/0.81×0.76)×10h (No. 3 boiler operation hours)×300day/a/1000 =259ton-steam/a
  259ton-steam/a×2,768MJ/ton/1,000=717GJ/a

Table 6-1: Boiler list in GKL

item	unit	boiler No.1	boiler No.2	boiler No.3	boiler No.4
Manufacture year:	-	1998	1998	2003	2006
Brand name	-	COCHRAN	COCHRAN	COCHRAN	COCHRAN
Origin	-	UK	UK	UK	UK
Types	-	Fire tube	Fire tube	Fire tube: Diesel	Fire tube: Diesel f
Evaporation capacity	kg/hr	3,630	4,535	1,500	5,000
Design pressure	bar	12	12	12	12
Working Pressure	bar	10	10	10	10
Fuel (Gas) Consumption	M3/hr Liter/hr	259	324	111	(353)
	M3/Day (Lt./month)	6,206	7,781	1,114	(3,528)
Remarks				Operation 10hrs/day	Standby for urgent (10hrs/month)

Table:6-2 Boiler condition in operation 12th Sept. (GKL)

item	unit	Boiler No.1	Boiler No.2	Boiler No3*1	Total
Steam Generating Capacity	**kg/hr**	**3,630**	**4,535**	**1,500**	**9,665**
Working Pressure (speculation)	**bar**	**10**	**10**	**10**	**-**
Feed water quantity	**kg/hr**	**3300**	**1400**	**930**	**5,630**
Steam pressure (actual)	**bar**	**7.7～8.3**	**7.7～8.3**	**7.7～8.3**	**-**
Load rate	**%**	**91**	**31**	**62**	**58**

*1: No.3 boiler is operated 10hrs/day, because it is specialized for garment factory

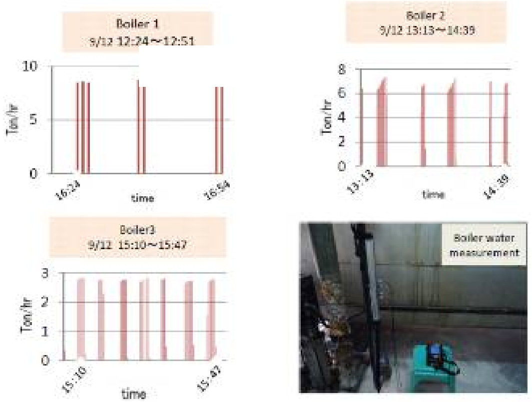


Figure 6-2 Boiler water supply condition & measurement

6-2. Thermal insulation for steam line

- There are many facilities without thermal insulation in boiler room and dyeing section; i.e. Steam pipes, valves and flange. Without thermal insulation protect heat losses, reducing boiler loading and electric power consumption.
- Even heat insulated have done, but already used quite long period, insulation material have worn out, it is better to change them periodically.
- Thermal loss without insulation on flanges and pipes at boiler site is shown in **Table 6-3**

Table 6-3 Steam loss from non-insulation or leaking valves

Valve size	Amount of steam diffusion		Valve	Steam leak amount
	MJ/set･hr	MJ/set･day	sets	MJ/day
50A	16.1	386	10	3,862
80A	26.7	641	5	3,205
100A	34.8	836	5	4,178
total			20	11,246

0.4MPa-steam: 2,738kJ/kg

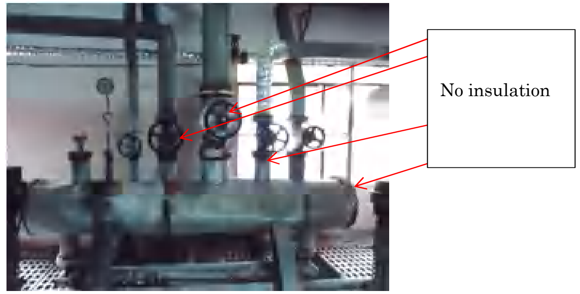


Figure 6-3 Steam header by boiler in GKL

- As **Table 6-3**, from 20 valves, 11,246MJ is lost in one day
- 11,246MJ/day×300day/year/1,000=3,374GJ/year

6-3 Steam trap maintenance

Steam traps are installed at the end of steam line to prevent loosing energy. Steam traps have some kinds to matching for its purpose. However steam traps are running always with main facilities and those are not looked after properly. Supposing non maintenance for steam traps, steam leaking should be happened. And caused by leaking, energy loosing will be increased seriously.

- There are two reasons for steam leaking from steam traps.
  1st reason is damaged steam trap itself without maintenance,
  2nd reason is that some steam is splashed out with condensed water by mechanical reasons.
  If steam amount is quite much, in that case it must change, because traps' construction or size is not suitable in steam facility.
  By the reasons of non-maintenance, leaked steam amount is shown in **Table 6-4**

Table 6-4 Steam loosing amount depending on leaking condition

Item	Amount of lost steam			No of traps	Total amount
	kg/hr/set	kg/day/set	MJ/day/set	sets	MJ/day
1. leaks out a little__	4	96	263	3	789
2. leaks out a middle	7	168	460	2	920
3. leaks out a lot___	15	360	986	2	9,857
Total				7	3,680

- Supposing 7 pieces traps are damaged, energy loosing is 3,680MJ/day
- 3.680MJ/day (3,680MJ/day×300day/year/1,000=1,104GJ/year

6-4. Electric power saving in wastewater treatment plant (WTP)

- WTP is adopted in activated sludge method, and 2 sets of air blower are supplied air for aerobic bacteria. Those blower motors have not variable speed systems.
- For activated sludge system, dissolved oxygen amount (DO) is very important parameter to keep condition steady always.
  By our DO measurement, oxygen concentration has been maintained under 5ppm as shown in **Table 6-5.**
  By the regulation of BGD, DO value must be more than 5.0 ppm, but excess than 5.5ppm is meaning of waste of electric power.
  To reduce air supply to aeration tank, it is some methods. (1) Cut air supply to close the air valve. (2) Change pulley diameter to slow down blower rotation. (3) Install inverter controller to change rotation speed. The system (3) can be reduced electric power.

Table 6-5 WTP condition

Name	Parameter	Data
Water Tank	DO	0.08
	Temp	46.9
	pH	9.4
	Electric conductivity	4,549
Primary Tank	DO	0.16
	Temp	32.2
	pH	11.1
	Electric conductivity	2,140
Aeration Tank	DO	5.76
	Temp	31.4
	pH	8.1
	Electric conductivity	2,290
Secondary Tank	DO	3.6
	Temp	31
	pH	8.1
	Electric conductivity	3,000

- Electric power consumption is 35kWh total, all most 60% of consumption is occupied by air blowers. Therefore DO management is important, always check DO value, and adjust motor rotation, as reasonable condition.
- Plant layout is quite well designed, but activated sludge system is needed return sludge line and control return sludge amount.

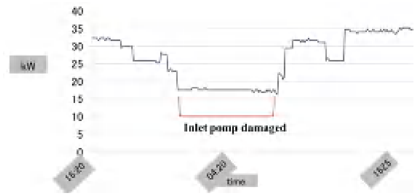


Figure 6-4 Electric power consumption at WTP (GKL)

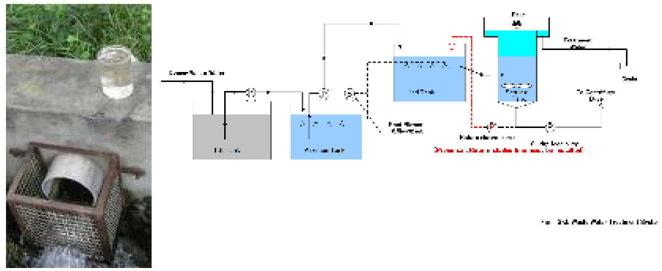


Figure 6-5 WTP in GKL

6-5. Steam condensate & warmed cooling water recovery

- In case of heat up substances, mainly latent heat in steam gives it function. After heating steam condensate is flush out from steam traps. Condensate has no latent heat, but still have sensible heat more less 100℃。
- Condensed drainage is not only useful for heat energy, but also water souse.
- The recovery system of condensed water is two ways. One is open system and other is closed one. Open system is going under atmosphere condition and closed system is under pressured condition.
- In case of open system, maximum temperature of condensed is 100℃, and investment is quite lower. On the other hand, closed system can be got condensed water in higher temperature. Therefore, closed system has advantage in the efficiency of recovering.
- In Grameen knit wear ltd, they have made condensed water pipeline to return boiler. But this pipeline has been mixed with cooling water, and finally they put some water before feed to boiler. The pipeline and water supply tank are shown following Figures.
- **<u>The Biggest Question of this pipeline</u>**
  (1) Boiler steam is used in dyeing & garment section, and steam is used under closed condition.
  (2) Wormed cooling water in 100% volume has been mixed to condensed water.
  (3) Temperature of lower received tank is 94℃、 however heed water tank temperature 60℃
  Total boiler supply volume is 5.6m^3 from **Table 6-2**
  Total calories for boiler supplied ; 5.6m^3 x 60℃=336Mcal
  Mixing ratio between condensed water and fresh water is needed formula as follows,

60℃ x 5.6m^3=336Mcal/hr. X; volume of condensed water,
Y; fresh water to feed upper supply tank
X + Y=5.6m^3, (94 x X)+ (30 xY)=336Mcal →X=2.6m^3, Y=3.0m^3

- **Boiler water is needed half amount from fresh water. Why??**
Condensed water from dyeing machine: 3m^3 (because plenty condensed water leaking)
It is estimation that warmed cooling water is going to WTP or outside drainage; it means warmed cooling water is not used at all. If warmed cooling water is mixed with condensed, condensed tank temperature go down to near 80℃。Off course, water volume is coming more.
By calculation from **Table 4-8**, cooling water amount is 140m^3/day. (5.8m^3/hour)
In common sense, condensed water and warmed cooling water come out same heat exchanger, but at outlet portion have two valves to separate each pipe. We have checked that both pipe jointed to one pipe as **figure 6-9** **Why why ????**
Suspicion & improvement;
(1) Condensed tank level controller is operated by manual operation; so plenty water flow out (over-flow). Therefore water lever control change to automatic.
(2)One big valve which is front of condensed water tank, that is suspects to not fix properly.

If it is resolved that the reason of warmed cooling water is disappeared, some heat energy can be saved.
Saving amount: (80℃-30℃) x 3m3/hr x 24hr=3,600Mcal(15GJ)/day=5.5ton-steam(1800Tk)

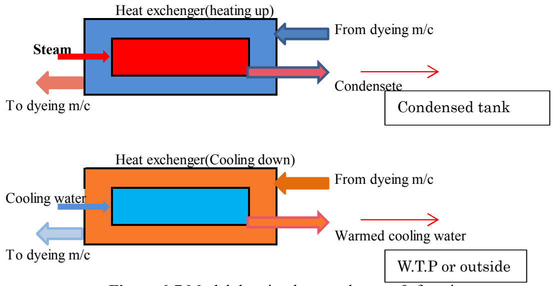


Figure 6-7 Model drawing heat exchanger & function

Table 6-6 Record of water tank for boiler feeding

		Steam Boiler		Feed water	
		Gas pressure	Steam pressure	Water level	Temp
		mbar	bar	Height(cm)	℃
9/10	8:00	80			
	9:00	80		90	60
	10:00	80	7.2	85	60
	11:00	80	7.3	80	60
	12:00	80	7.2	75	60
9/11	7;00	100	8.0	100	60
	8:00	100	7.9	95	60
	9:00	100	7.8	90	60
	10:00	100	8.0	85	60
	11:00	100	7.9	80	60
	12:00	100	7.7	75	60

9/12	7;00	100	8.3	100	60
	8:00	100	8.2	95	60
	9:00	100	8.0	90	60
	10:00	100	8.3	85	60
	11:00	100	8.2	80	60
	12:00	100	8.0	75	60

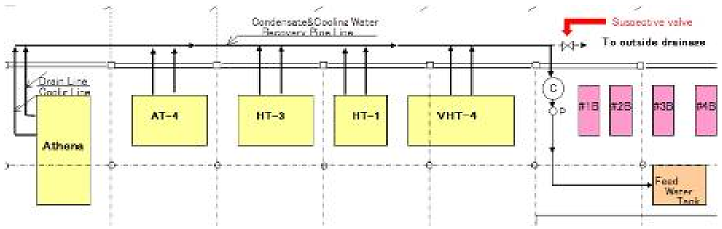


Figure 6-8 Condensate & cooling water pipeline in GKL

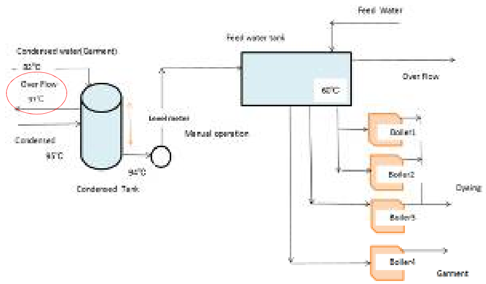


Figure 6-9 Condensate and feeding tank in GKL

6-6. Supply water for boiler

- Supply water for boiler must be soft one. As supplied water hardness and conductivity are higher than standard, so the scale is covered inside wall of boiler.
- Boiler No.1 and 2 are supplied quite harder water. Suspected some scale which is based on calcium is contained boiler inside. If scale thickness is 0.3mm, boiler fuel will need 1% more. Shown **figure 6-10.**
- If non maintenance or poor management for boiler water like proper blow down amount, you may suffer loss in one year as follows;
5.6ton-steam/hr×24hr×300day/year×0.01＝403ton-steam/year、
403ton-steam/year×2,768MJ/ton/1,000=1,115GJ/year

Table 6-6 boiler supply water quality 12th Sept. (GKL)

	Hardness	Electrical conductivity	Temp
		μs	℃
Raw water	50	164	28
Softener water	0	168	28
Boiler water 1	0～10	9,425	-
Boiler water 2	0～10	6,934	-

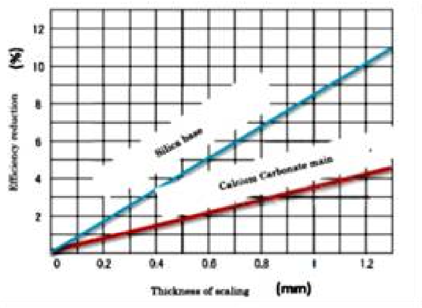


Figure 6-10 Boiler effect reduce by inside scaling

6-7.Energy saving in compressor

- ◆ Three compressors are installed, one of them is standby. Operated two are 55kW & 37kW electric powers. On-off setting is on-load 5.1br and off-loads 5.3br.
  Electric load rate is 67% to 69% and 63kW is power consumption.
- ◆ Energy saving will be reach to set up the pressure reduction. **(Table 6-8)**
- ◆ Most effective way is to check leaking portion in all air pipe and joint portions.
  In holyday, operate compressors, and stop compressors and check the receiver tank pressure down first. If pressure down is very quick, check all pipe line. (Pressure drop test)
  This is very simple way and no investment; therefore this test must carry on every year once.

Table 6-7 Compressor operation condition

		Ampere	Voltage	Output	Load rate
unit	kW	A	V	kW	%
Compressor No.1	55	64	400	38	69
Compressor No.2	37	42	400	25	67

Table 6-8 Compressor operation to save energy countermeasure

Counter measurement	Detail	Effect
Blow out pressure	Reduce 1bar	4～5%
Temperature management of inlet air	Temperature range reduction 30～10℃	3%
Check soaking pressure load	Reduce 200mmAq	1%

Figure 6-11 Air receiver in GKL

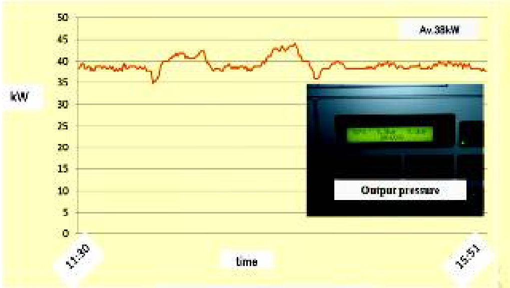


Figure 6-12 No.2 compressor power consume & pressure gauge

7. Conclusion

As above mentioned, our conclusion is as follows,

- ◆ Energy and water cost are very lower than other country. Particularly gas cost is surprised. Its cost is 1/12 of Japan, and 1/4 of Indonesia.1/5 of China. Companion with caloric base: shown in **Table7-1**

Table 7-1 Main energy sources cost comparison (Unit=¥ or Tk)
10Gcal (41.86GJ): Natural gas is 1000m3, Coal: 2,000kg, Heavy oil: 1,100liter

	Bangladesh	China	Indonesia	Japan
Natural gas	6,000	40,800	30,000	75,000
Coal (5000kcal/kg)		18,200	13,000	55,000
Heavy oil(9800kcal/lit)		40,000	40,000	68,000

Table 7-2 other sources cost

	Bangladesh	China	Indonesia	Japan
Electric power(kWh)	6.49	9.75	5.80	11.00
Industrial Water(m3)	22.43	11.70	14.17	25.00
GNP/person US$ (WHO 2010)	1,840	7,640	4,200	34,640

(GNP is different from personal income. Personal income is not same as **Table 7-2.**)

Under those circumstances, the big amount of investment to improve energy conservation is quite difficult. We can propose some idea to improvement, but those have limitation when they consider the payback period.
According to payback period, it is 5 to 7 years in the countries of developed, but in developing countries, it is common that the terms are more less 2 years.
Now we classify our proposals to three degrees; (1) lower or no investment payback less 0.5year, (2) payback period within 2 years, (3) payback period more than 2 years.
We don't propose highly amount investment to big revolution for changing the production and utility systems.

◆ We show some reference **Table 7-3 & 7-4** in another countries. Their energy cost quite higher than BGD, and already they have started energy saving countermeasures.
BGD's textile or garment materials have power to compete other countries, however you mast set up strategy how to minimize energy consumption in each factories & country plan.

7-1.Proporsal for Landmark Fabric ltd

Table 7-1 Summary of the proposal from JTCC investigation at LFL

Item		Saving (GJ)/a	Saving/a Steam-ton	Saving/a	Invest	Payback (year)
				Unit=1,000 Tk		
Process Innovation						
4-1	Cooling water utilization	16,260	5,940	3,200	1,000	0.3
4-2	Heat exchanging from wastewater	14,922	5,460	3,000	10,000	3.3
4-3	Heat insulation to dyeing machine	1,285	471	256	500	2.0
Utility innovation						
5-1	Steam condensate recovery	16,308	5,969	3,240	1,000	0.3
5-2	Heat exchanger from chimney hot air	14,466	338,000 m3-gas	2,700	5,000	2.0
5-3	Steam boiler by exhaust hot air from generator	20,789	486,000 m3-gas	3,888	10,000	3.0
5-4	Thermal insulation for steam line	5,961	2,170	1,180	500	0.4
5-5	Steam trap maintenance	4,041	1,475	800	1,000	1.1
5-6	Boiler efficiency improve (management)	2,709	63,000 m3-gas	504	100*1	0.2
5-7	Wastewater treatment Electric saving					
	Total saving	96,741	**(38.5%)**	18,768	17,600	Av: 1.1

*1: boiler water quality measurement tools
Production: 15ton/day x 300days=4,500ton/a
Steam consumption: 306ton/day **(Table 5-1)** x 300=91,800ton-steam/a
Total energy: 91,800ton x 2,738MJ/ton-steam=251,348GJ
<u>Saving rate by the innovation</u>: 96,741GJ/251,348GJ x 100=**<u>38.5%</u>**

7-2. Proposal Grameen Knitwear ltd

Table 7-2 Summary of the proposal from JTCC investigation at GKL

Item		Saving (GJ)/a	Saving/a Steam-ton	Saving/a	Invest	Payback (year)
				Unit=1,000 Tk		
Process Innovation						
4-1	Cooling water utilization	11,000	4,020	2,187	1,000	0.5
4-2	Heat exchanging from wastewater	9,931	3,660	2,000	6,000	3.0
4-3	Heat insulation to dyeing machine	400	147	800	500	1.5
Utility innovation						
6-1	Steam boiler efficiency by less load	717	252	137	0	0
6-2	Thermal insulation for steam line	3,374	1,243	676	500	1.3
6-3	Steam trap maintenance	1,104	408	222	500	2.5
6-5	Steam condensate for boiler water	4,500	1,650	898	0	0
6-6	Boiler water management	1,209	445	242	100*2	0.4
6-4	Wastewater treatment Electric saving					
6-7	Electric power saving for compressor					
	Total saving amount	32,235	**(34.8%)**	6,442	8,600	Av: 1.3

*2: boiler water quality measurement tools
*Steam consumption: 113ton/day **(**from **Table 6-2)** x 300=33,800ton-steam/a
Total energy: 33,800ton x 2,738MJ/ton-steam=92,544GJ/a
<u>Saving rate by the innovation</u>: 32,235GJ/92,544GJ x 100=**<u>34.8%</u>**

7-3. comparison with other country (for reference)

Table 7-3 Indonesia Integrated factories (Spinning, Weaving & Dyeing total produced)

	Energy intensity GJ/day			Base line GJ/day			Saving Potential (%)		
factory	Elect.	Heat	Total	Elect.	Heat	Total	Elect.	Heat	Total
A	236	116	352	846	1,536	2,382	27.9	7.6	14.8
B	139	201	340	986	1,088	2,074	14.1	18.5	16.4
C	84	280	363	662	1,059	1,721	12.6	26.4	21.1

Table 7-4 Yarn Dyeing & Finishing Factory in China

	Steam consumption ton-steam (GJ)	Saving Potential energy (GJ/year)	Saving Potential (steam-ton)	Saving money 2100Tk/ton-steam
Preparation	14,197	9,059	3,318	
Dyeing facilities	66,050	44,230	16,982	
Total	80,247(219,716)	53,289(24%)	19,520(24%)	40,992,000/year

END

APPENDIX

1. Research Schedule at Bangladesh Dye-houses

Date	Position	Remarks	Date	Position	Remarks
8/31(Fri)	Dhaka arv.		9/8 (Sat)	Landmark	Additional data collection
9/1 (Sat)	Preparation		9/9 (Sun)	Grameen	Dyeing mc & Water pipe
9/2 (Sun)	W.S.T	1st Presentation.	9/10 (Mon)	Grameen	Dyeing mc Boiler & Steam line
9/3 (Mon)	Landmark	Dyeing mc & Water pip	9/11 (Tue)	Grameen	Finishing mc & wastewater
9/4 (Tue)	Landmark	Dyeing mc Boiler & Steam line	9/12 (Wed)	Grameen	Additional data collection
9/5 (Wed)	Landmark	Finishing mc & wastewater	9/13 (Thu)	W.S.T	3rd Presentation
9/6 (Thu)	W.S.T	2nd Presentation.	9/14 (Fri)	Dhaka Dep.	Transfer at BKK
9/7 (Fri)	Holiday		9/15 (Sat)	KIX	

2. Factories Profiles

	Landmark Fabrics Ltd (Landmark Group)	Grameen Knitwear Ltd (Grameen Bank Complex)
Establishment	2001	1998
Number of working person	D & F:200 (3-shifts) Garment:800 (day shift only)	D & F: 500 (3-shift) Garment: 2,500 (day shift only)
Production	Circular knit fabric :1 5tons/day (Max : Cotton, CVC 10tons each/day)	Circular knit fabric: 8tons/day (normal production: 7tons/day)
Raw materials	Cotton, CVC, Polyester 100% With some elastic yarn	Cotton, CVC with elastic yarn
Production m/c	Thies & Fong's HT dyeing m/c Dryer, Slitter, Stenter	Sclavos HT & AT dyeing m/c Dryer, Slitter, Stenter
Utility	3 Gas boiler, Diesel & Gas generators	4 Gas boiler, Diesel generators
Water & Wastewater	3,600m3/day included other factories	800m3/day to dyeing WST:720m3/day

3. Main facilities in Landmark Fabric Ltd Dyeing & Finishing

M/C name	Capacity	Spec.	Character	Remarks
Thies No1.	150kg	1 flow	HT Round Jet	
Thies No2.	300kg	2 flows	HT Round Jet	
Thies No3, No.4	450kg	3 flows	HT Round Jet	Extensible 6 flows
Thies No.5,No6	800kg	4 flows	HT Round Jet	
Thies No.7	1200kg	6 flows	HT Round Jet	Under repair
Fong's No.1	600kg	3 flows	HT Round Jet	
Fong's No.2,No.3	800kg	4 flows	HT Round Jet	
Fong's No.4	1500kg	8 flows	HT Round Jet	
Splitter	10 tons/day	With retwist		Laser search
Padding Dewater	8 tons/day	Open width		Mangle type
Dryer	8 tons/day	Tube type	Net Conveyer	Gas burner
Stenter for Finish	8 tons/day	With Padder	Vertical 8 chambers	Gas burner
Stenter for Pre-set	10 tons/day	With Padder	Horizontal 10 chambers	Gas burner

4. Dyeing and finishing facilities layout at Landmark Fabric Ltd

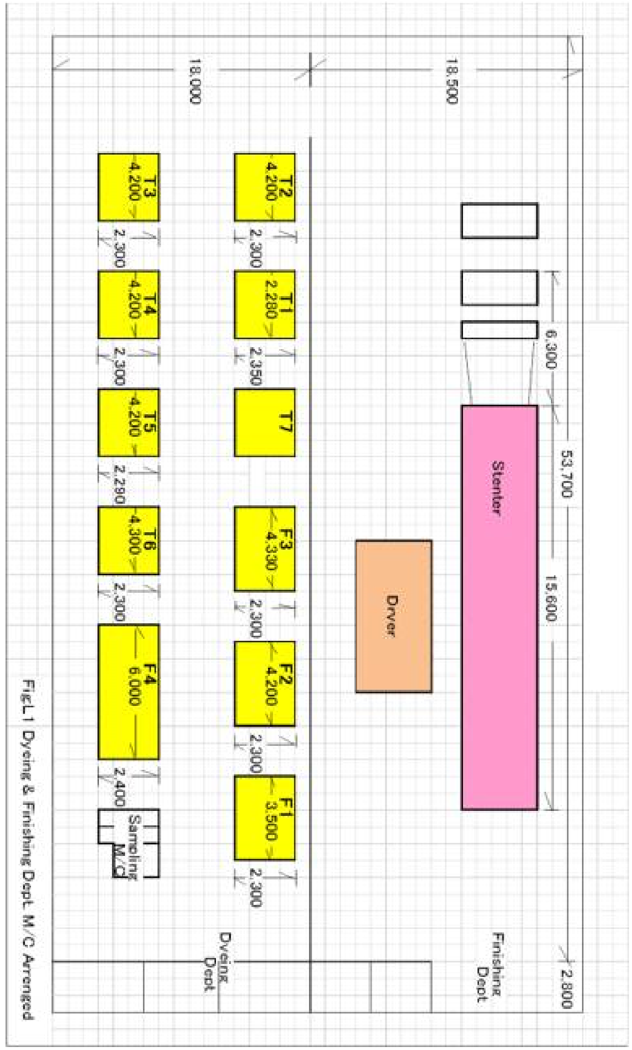
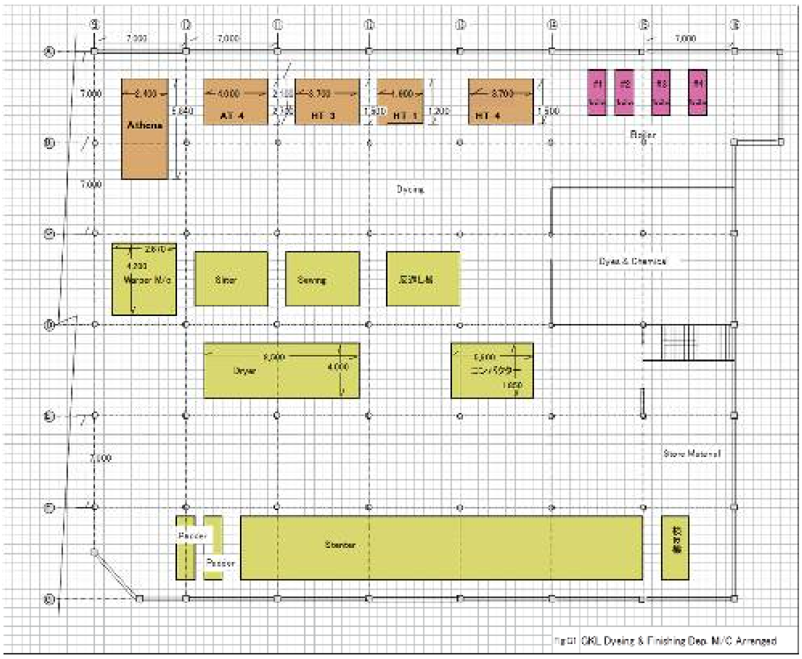


Fig.L1 Dyeing & Finishing Dept. M/C Arranged

6. Dyeing and finishing layout at Grameen knitwear Ltd



5. Dyeing machines profile in Landmark Fabric Ltd

7. Dyeing machines profile in Grameen knitwear Ltd

ATHENA	AT-4	HT-3	HT-1	HT-4
1000kg	540kg	720kg	180kg	720kg
Jet HT	Jet AT	Jet-HT	Jet-HT	Jet-HT
CVC/PET/C100	Cotton only	CVC/PET/C100	CVC/PET/C100	CVC/PET/C100

8. Investigation planning for each facility in dyeing & finishing

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Dyeing m/c	1	Electric Power consumtion	E.Power meter		Select the biggest capacity m/c
	2	Feeding water volume	Visual inspection	Prompt	Check to progrum data
	3	Feeding water volume for cooling	Ultrasonic flow meter		Compereing with Progrum chart
	4	Cooling water Temperature	Thermistor thermometer	Prompt	
	5	Feeding water temperature for dye bath	Thermistor thermometer	Prompt	
	6	Drain water temperature	Thermocouple thermometer		
	7	Jet m/c wall temperature	Radiation thermometer	Prompt	Record both dyeing and surface
	8	Drain water analize	pH & Conductivity meter	Prompt	Rinsing water after dyeing
	9	Fabric weight in dyeing	Visual inspection	Prompt	Possibly sampling

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Dryer	1	Water content before drying	Balance	Prompt	
	2	Operatin speed	tachometer	Prompt	Compering with m/c indicator
	3	Temperature (PS & PV)	Visual inspection	Prompt	
	4	Dryer wall temperature	Radiation thermometer	Prompt	Compering with m/c indicator
	5	Air volume from exhaust duct	Anemometer	Prompt	Must be under 50℃
	6	RPM in exhaust fan	Visual inspection	Prompt	Must check any alteration by condition
	7	Exhaust fan power consumtion	Visual inspection & Clamp	Prompt	Must check any alteration by condition
	8	Hot air temperature from exhaust duct	Thermistor thermometer	Prompt	Permission to make hole to chimney
	9	Fabric surface temp. at outlet	Radiation thermometer	Prompt	
	10	Inlet aspiration air volume	Anemometer	Prompt	Check air blow direction
	11	Outlet aspiration air volume	Anemometer	Prompt	Check air blow direction
	12	Fly dust filter condition	Visual inspection	Prompt	
	13	Gas consumption	Factory's meter & record	Copy	Check consumption by drying batch
	14	Electric Power consumtion	E.Power meter	Continuous logger	No needed in case of continuous operation

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Stenter	1	Electric Power consumtion	E.Power meter	Continuous logger	
	2	Water content before drying	Balance	Prompt	
	3	Operatin speed	tachometer	Prompt	Compering with m/c indicator
	4	Temperature (PS & PV)	Visual inspection	Prompt	
	5	Insulation wall temperature	Radiation thermometer	Prompt	Compering with m/c indicator
	6	Air volume from exhaust duct	Anemometer	Prompt	Must be under 50℃
	7	RPM in exhaust fan	Visual inspection	Prompt	Check fan & motor spec.
	8	Exhaust fan power consumtion	Visual inspection	Prompt	Must check any alteration by condition
	9	Hot air temperature from exhaust duct	Thermistor thermometer	Prompt	Permission to make hole to chimney
	10	Fabric surface temp. at outlet	Radiation thermometer	Prompt	In case for drying
	11	Inlet aspiration air volume	Anemometer	Prompt	Check air blow direction
	12	Outlet aspiration air volume	Anemometer	Prompt	Check air blow direction
	13	Gas consumption	Factory's meter & record	Copy	Check consumption by drying batch
	13	Fly dust filter condition	Visual inspection	Prompt	

9. Investigation planning for each facility in Utility

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Boiler	1	Steam consumption (water supply)・Pressure	Factory's meter Visual inspection	day average	Copies of factory'srecords
	2	Blow loss・Time・Volume	Stopwatch	Prompt	refer factory data in past.
	3	Blow water quality	pH & Conductivity meter	Prompt	Measurement by beaker after cool down to collected water
	4	Fuel consumption	Factory's daily record for boiler	Copy	
	5	Feed water temperature	Thermocouple thermometer	Continuous logger	
	6	Condensed water temperature	Same as above	Continuity	Balance between the amount of water
	7	Steam trap	Visual inspection	Prompt	steam leak etc.
	8	Boiler equipment	Factory's electricity meter or clamp meter	Prompt	Gas compressor exhaust fan water pump each other – (individual)
	9	Boiler feed water quality	Simple hardness kit & conductivity meter	Prompt	
	10	Exhaust gas temperature (inlet and outlet)	Thermistor thermometer	Prompt	Presence or absence of air heater and economizer
	11	Fuel calorific value	Gas supplier's data	Copy	
	12	Amount of supplied soft water	Ultrasonic flow meter	Continuous logger	Check in the amount of condensed water to boiler

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Water supply and wastewater	1	Electricity consumption of Waste water treatment equipment	Factory 's Electricity meter or clamp meter	Prompt / day average	each blower・pump・agitator etc. (required each equipment)
	2	Water processing equipment	Factory's Electricity meter or clamp meter	Prompt / day average	
	3	Water hardness	Chemical drop testing	Prompt	
	4	Quantity of supply water	Factory's Meter & record	Copy	
	5	Feed pump (electricity)	Clamp	Prompt	
	6	DO levels of the wastewater treatment equipment	DO meter	Prompt	
	7	Inlet temperature of wastewater treatment	Thermocouple meter	Continuous logger	
	8	Volume of wastewater	Factory's meter	Record copy	
	9	Inlet and outlet water quality of waste water treatment	Data of factory's record the	Copy	BOD / COD / T-N / SS / MLSS etc.

Measurement process	Number	Measurement item	Measuring instrument	Frequency	Notes for measurements
Compressor	1	Over all capacity	Current meter, stopwatch, inspection	Individual check	ON-off timing
	2	Air leak	Listening	Checked at opening time	Consider on site
Piping	1	Heat insulation	Radiation thermometer	Prompt	Including the steam header
Receiving and distribution	1	Power Consumption	Factory's meter	Continuity	If you have a large receiving point is the location of the MAX
	2	Power factor	Check sites meter & record	Prompt	
	3	Maximum electric power	Check Factory's daily record	Copy	
Factory environment	1	Lighting condition	Light meter	Prompt	Each process
	2	Temperature and humidity	Thermo-hygrometer	Prompt / day average	Knitting process

To check each motor control (Inverter or manual)

10. Peoples who have supported JTCC works