RECP Experiences in Textile Sector, Gujarat, India

Achievements at a Glance

Gujarat Cleaner Production Centre (GCPC) is working with Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) GmbH – Germany and Gujarat Pollution Control Board on best available techniques implementation in Textile in Gujarat. Using the case studies from various Best Available Techniques Reference Documents, Guidance of Sector Specific Experts and Industries, 15 different pilot case studies were identified and implemented. The total investment is USD 757859.37 **(One time)** and saving was USD 668500 **(Yearly)** with shortest payback period in some pilot was 10 Days. The BAT involves the improvement targeting resource efficiency, process improvement, energy efficiency and reduced environment impacts, by employing appropriate technologies, both environment and economic gain as achieved.

Overview

The textiles sector has relevance as is widely known to be an energy and water intensive sector, also having greater implication from the environmental angle. 'Environmental Friendly Technologies/Techniques' could play a significant role in reducing the negative environmental impact provided suitable approach is adopted and right kind of technology is selected by the industries.

Under this, Potential industrial cluster (s) was identified by consultations with the industrial association and industries and volunteering industries were identified for implementation. Total 15 textile units were sleeted for pilot scale study and the baseline situation of the selected industry with identification of core environmental issues like resource efficiency inefficient operations, pollution problems etc were documented.

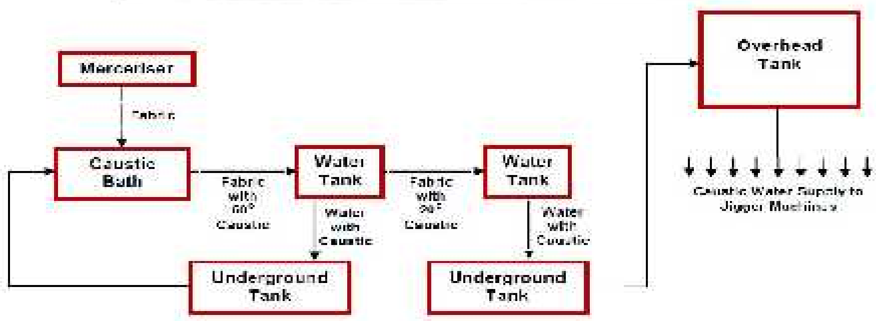
The studies helped to develop Action Plans in these industries for undertaking environmental improvements by making improvements targeting resource efficiency, process improvements, energy efficiency and reduced negative environmental impacts. By employing appropriate technologies, both environmental and economic gains have been achieved. Also, the case studies helped in documentation of possible improvement in the identified industry sectors and dissemination amongst those sectors.

Benefits:

Case Study: 1 Reuse of Alkaline Stream from Mercerising

Problem: In mercerising process, fabric is treated with caustic soda (NaOH) solution. Caustic soda reacts with the cellulose, swells it and imparts properties like strength, improve lustre and increase absorption of the fabric for dyes. The alternate to recover caustic is caustic recovery plant which requires significant capital investment and also running cost in form of steam and manpower. After treatment, fabric is washed with water with starching tension to remove un-reacted caustic soda (98 to 99 % of unreacted caustic) from the fabric. This wash water contains substantial amount of caustic soda which is not only the resource loss but also it generates pollution in the wastewater (higher COD, TDS, TSS, alkalinity etc).

Pilot measure: Industry has gone through the process waste stream identification and probable processes for reuse of the waste streams and after process modification, the alkaline stream is collected in underground tanks of which 50^0 caustic stream is collected and reused for next batch while the 20^0 caustic stream is pumped to overhead tank and is supplied through common line with tapings to individual jigger machines for use during next process i.e., dyeing process where the alkaline stream is used for boiling and bleaching of fabrics.



Benefits:

- Reduction of caustic consumption by 15000 kg per year.
- Reduction of CETP charges in future for the volume of waste water reduced

Cost benefit analysis: Capital cost for implementation was USD 7812.5 with negligible operating cost giving total savings of USD 8437.5 per annum with payback period of 12 months.

Case Study: No:2 Reuse of Treated Water for Washing at Printing Machines

Problem: Screen is used for printing designs. When designs or colours on design are changed then screen is washed. Similarly the frames also need washing on change overs.One Printing machine requires 1500 lit/hr for continuous cleaning of the blanket and screens, therefore in it requires 150 KL of water per day. During washing wash water is generated, which is treated in ETP.

Pilot measure: The ETP plant treated water is recycled for its use in cleaning process of screen & frames. In house piping arrangements were made to divert the ETP treated water for cleaning at printing machines through an overhead tank.

Benefits:

- Reduced fresh water consumption by 150 KL per day
- Reduction of CETP charges in future for the volume of waste water reduced

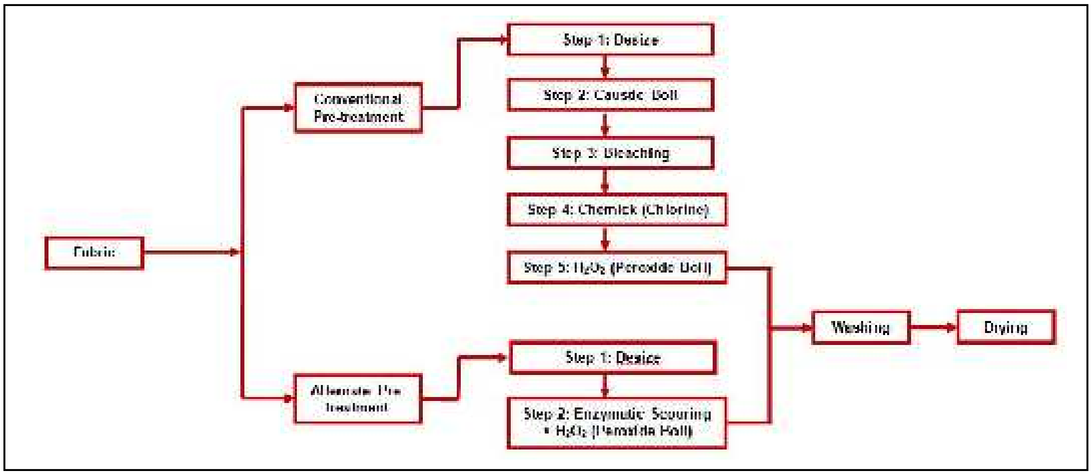
Cost benefit analysis: Capital cost for implementation was USD 1562.5 Operating cost for running pumps of 6 HP for water transfer of USD 2640.625 per annum giving total savings of USD 5414.06 with payback period of 10 months.

Capital cost for implementation was USD 4687.5 Operating cost for running pumps of 7.5 HP for water transfer of USD 1343.75 per annum giving total savings of USD 4031.25 with payback period of 21 months.

Case Study: No:3 Replacement of alkaline scouring with bio-scouring enzyme for enzymetic scouring.

Problem: Scouring is carried out to remove impurities that are present in cotton. This is usually done at high temperatures (above 100 °C) with sodium hydroxide. Produces strongly alkaline effluents (around pH 12.5) with high organic loads, tend to be dark in colour and have high concentrations of Total Dissolved Solids (TDS), oil and grease in wastewater. The processing cost of fabric was Rs. 5.15 per kg of fabric

Pilot measure: Replacement of alkaline scouring in the manufacturing process with bio-scouring enzyme for enzymatic scouring with chemical supplied by Camex, Ahmedabad, also available with Novozyme



Benefits: Bio-scouring process provides many advantages, such as reduced water and wastewater costs, reduced treatment time and lower energy consumption because of lower treatment temperature. Commercial bio-scouring enzyme products are based on pectinases which are used for enzymetic scouring. Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of enzymatic scouring process are 20-45 % as compared to alkaline scouring (100 %). Total Dissolved Solid (TDS) of enzymatic scouring process is 20-50% as compared to alkaline scouring (100%).

Bio scouring resulted in following benefits:

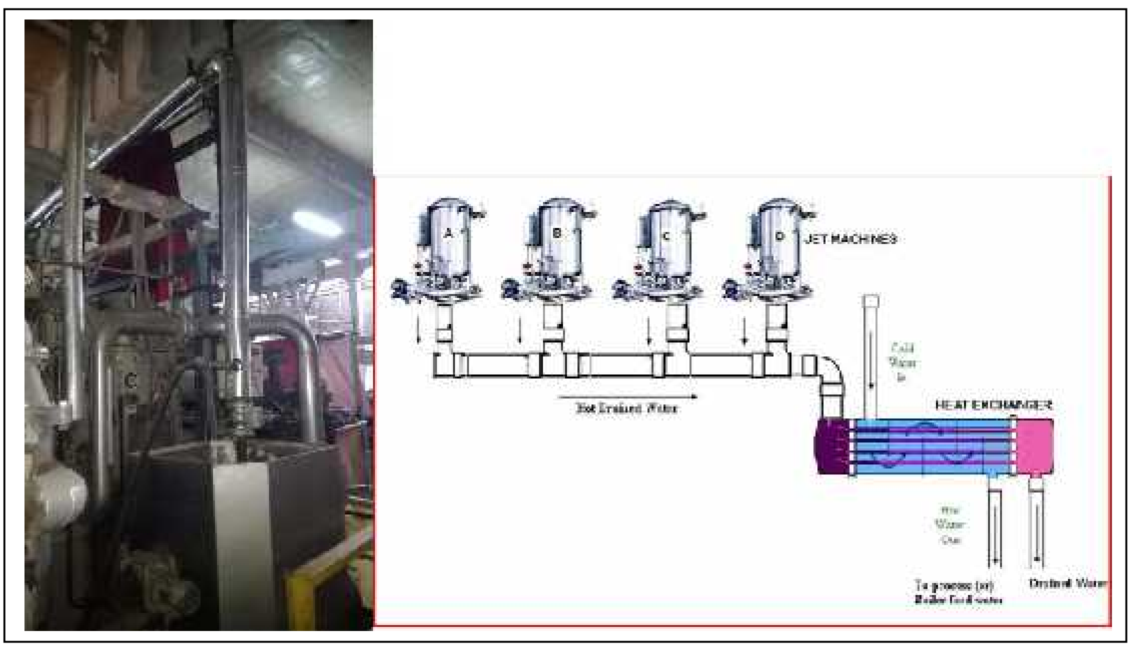
Water consumption reduction: 45.45%
Chemical consumption reduction: 8.65%
Electrical power consumption reduction: 37.04%
Fuel (coal) consumption reduction: 24.55%

Cost benefits analysis:
The processing cost of fabric reduced to Rs. 3.91 per kg of fabric. There is no capital cost required since only replacement of chemical is required (although with 10 % additional cost compared to existing chemicals), the total savings achieved was USD 78468. 75 per annum.

Case Study: No: 4 Recycle/reuse of cooling water and condensate water as boiler feed water.

Problem: Cooling water and condensate water are non-process water uses. Many cooling water systems are operated on a once-through basis. Condensate water includes water from heat exchangers in dyeing machines, drying ranges, cooling cans on continuous ranges, while cooling water includes hot water from jet dyeing machine and compressors (if water cooled).In the knit industry for example, the amount of cooling water utilized in the process is equivalent to 13% of total fill and rinse water. Traditionally, jet dyeing machines are equipped with common heat exchangers that are used for both heating and cooling which is normally drained with other effluent and thus increasing fresh water consumption as well as effluent quantity & load at ETP.

Pilot measure: Both the cooling water and the condensate is recovered completely from jet dyeing machines and reused as boiler feed water in Rinkoo Processors. While cooling water from jet dyeing machines is reused as process hot wash water on soft flow dyeing machines, RFD (Ready For Dyeing) machines, etc. in KomalTexfab.



Benefits:

- The total boiler feed water is being now catered by recovered condensate & cooling water amounting to 50 KL per day.
- Boiler feed water consumption reduction: 100%

- Recovery of energy in form of heat from hot water: 15%
- Reduction in boiler emissions
- Reduction in waste water generation (quality & quantity)

Cost benefit analysis: Capital costs for implementation was USD 4687.5 operating costs includes the pumps operation of 10 HP for transfer amounting to USD 4890.62 per annum, resulted in saving of USD 51562.5 per annum with payback period of 3 months.

Capital costs for implementation was USD 17187.5, while operating costs includes the pumps operation of 10 HP for transfer amounting to USD 3062.5 per annum, resulted in saving of USD 18937.5 (USD 9292.96 fuel cost + USD 9652.5 fresh water pumping cost) per annum with payback period of 13 months.

Case Study: No: 5 Water Consumption Optimisation at Jigger Machines

Problem: In overflow rinsing, clean water is fed into a machine and drained through an overflow weir usually set near a normal running level. Overflow rinsing is inefficient in terms of water use as clean water is often fed into a machine with the control valve fully opened thus having 3 times (1200 litre/batch) higher flow rate of overflow water required.

Pilot measure: Installed two separate water lines for jigger machines, for water filling (1.5 inch) with auto timer based controller to fill required quantity of water into jigger, for overflow (0.5 inch) line with auto timer controller which allows only 400 litre per 20 minutes and stops the water flow after one turn. Also the water supplied to the jigger is from condenser cooling water of caustic recovery plant which in turn saves the 30 KL/yr of additional fresh water consumption.

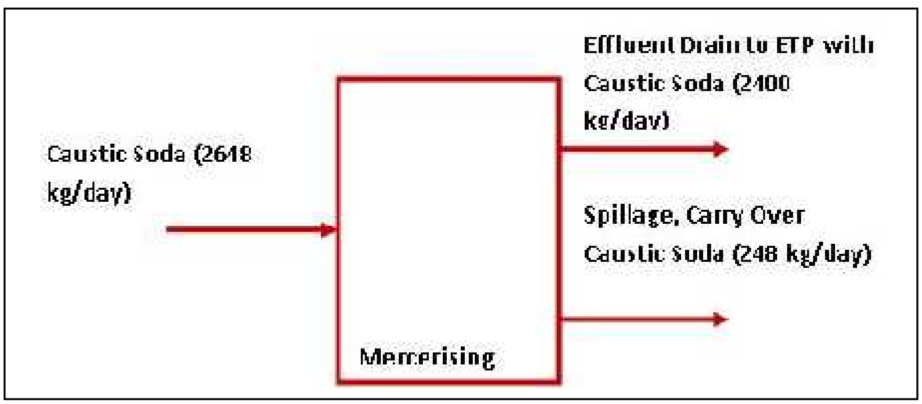
Benefits:

- Economic savings with reduced fresh water consumption by 360 KL per year
- Reduction in effluent generation due to reuse of cooling water.
- Reduces the load on ETP and reduction of CETP charges in future for the volume of waste water reduced

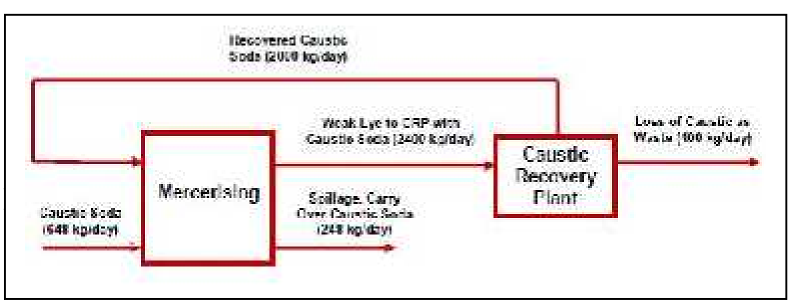
Cost benefit analysis: Capital cost for the modification was USD 3125 per jigger with water saving of 360 KL/yr. Although the fresh water cost is not significant, the payback in this case is not fast considering the fresh water cost only.

Case Study: No: 6 Caustic Soda Recovery System

Problem: A large quantity of caustic soda is used in different processes of textile processing of the industry, most notably in mercerization process. Mercerization is the treatment of cotton under tension with caustic soda solution at 150 - 200 ^{0}C for 25- 40 seconds. For this purpose fibres and fabrics are impregnated within a caustic soda solution. Fabric is treated with caustic soda (NaOH) solution. Caustic soda reacts with the cellulose, swells it and imparts above properties. After treatment, fabric is washed with water with starching tension to remove un-reacted caustic soda (98 to 99 % of unreacted caustic) from the fabric. This wash water contains substantial amount of caustic soda which is not only the resource loss but also it generates pollution in the wastewater (higher COD, TDS, TSS, alkalinity etc).



Pilot measure: Caustic Soda Recovery System separates the weak lye (wash liquor) into strong lye and vapour condensate (slightly alkaline soft water). The condensate can be used for pre-washing and the caustic soda can be reused in the mercerizing process.



- Chemical (Caustic) consumption reduction: 75%
- Reduction in waste water generation (quality & quantity)

Cost benefit analysis: Capital cost for caustic recovery plant was USD 144375 with operating costs of USD 75328.12 per annum giving total savings of USD 221875 with payback period of 12 months.

Case Study: No: 7 Optimisation of Heat Energy in Jigger Machines

Problem: Hot water is required for Dye application, Dye fixation, soaping etc. in a Jigger Dyeing Machine. The Jigger Dyeing Machine is required for Dyeing of cotton fabric or cotton content of the blended fabric. Dyeing of cotton fabric requires hot water at temperatures 80°C to 96°C depending upon the type of dye used. Heat for raising this hot water was drawn from steam raised in boiler by direct injection to water in jigger machine at approx. 3 kg/cm^{2}g, thus significant amount of heat was required to raise the water temperature also the high steam pressure leads to higher velocity which escapes from the water bath of jigger to atmosphere without delivering the heat and increase the steam consumption further due to losses. Average specific steam consumption at jigger machine was 1.5 to 2 kg of steam per kg of fabric.

Pilot measure: The water supplied to the jigger is from condenser cooling water (soft water) of caustic recovery plant at 50 ^{0}C, thus the water is preheated and will need steam only to raise temperature from 50 ^{0}C to average 85 ^{0}C. This hot water is further heated in closed tank with direct steam injection at 1 kg/cm ^{2}g pressure only to utilise the full heat content of the steam. The machines are supplied with hot water directly instead of heating water at machines. To maintain the required temperature during the process there are seamless SS coils at bottom of the jigger machines to provide indirect heating through thermic oil available.

Benefits:

- Reduction in coal consumption by 102 tons per year.
- Reduction in fresh water consumption of 30000 KL per year
- Reduction of CETP charges in future for the volume of waste water reduced
- Reduced emissions from boiler

Cost benefit analysis: Capital cost invested for the various modifications was USD 21093.75 with total savings of USD 13593.75, with negligible operating cost giving payback period of 18 months

Case Study: No: 8 Optimisation of Exhausts by Controlling the Exhaust Humidity with Automation

Problem: In Cotton Printing, Stenter is used before printing but after pre-treatment. In case of Polyester or PC Dyeing, stenter is used twice, once for heat setting and then again for final finish. Only 5.4% of heat given to stenter is utilized in heating the fabric in case of Heat Setting. Heat gained by fabric in any typical stenter operation is 4.6% only. It is further evident that approx. 95% stenters are used for the purpose of moisture evaporation, released to atmosphere or wasted.

Pilot measure: Instruments are available which automatically control the dampers to maintain exhaust humidity within this specified range thereby cutting air losses without significantly affecting fabric throughput. By installing the exhaust moisture controlling system (retrofit), the moisture % age required to be present in the finished fabric is set and optionally if required speed of the fabric is varied so as to attain exact moisture % age. Proposed equipments are available with Vibha Power Solutions Pvt. Ltd., Indore, M.P.

Benefits:

- Reduction in consumption of electrical power: 5-10%
- Reduction in consumption of fuel (coal): 20%
- Reduction in thermic fluid heater emissions.
- Reduction in process time.

Cost benefit analysis: Capital cost of the equipment is USD 2578.12, No operating costs involved, estimated saving is USD 2890.62 (@ 5 % savings) with return of investments in 11 months.

Case Study: No: 9 Low Liquor Ratio Jet Dyeing Machines

Problem: Jet dyeing machine dyes the cloth by forcibly contacting the jet flow of dye stuff solution. It executes efficient dyeing in such a manner that the tension on the cloth is decreased as much as possible, and that the cloth dyes evenly with a relatively small amount of dyestuff. Current Jet dyeing machines operate at a liquor ratio of 10:1, thus resulting in excess water consumption and in turn excess waste water generation. One factor limiting implementation is the high cost of the new machines, which favours use at new facilities rather than as replacements for older machines

Implemented measure: Machines of newer designs operate at a liquor ratio of 7:1. These machines usually incorporate low-friction Teflon internal coatings and advanced spray systems to speed rinsing.

Benefits:

- Reduced water consumption: 30%
- Reduced electrical power consumption: 20%
- Reduced fuel (coal) consumption: 30%
- Reduced consumption of chemicals & auxiliaries.
- Reduction in waste water generation (quality & quantity)

Cost benefits analysis:

Capital cost of 900 kg/hr machine was USD 195312.5, with reduced operating cost than conventional jet dyeing machines total savings achieved was of USD 29531.25 per annum giving payback period of 80 months (Excluding cost of chemicals saving & waste water treatment & disposal cost).

Case Study: No: 10 Installation of Variable Frequency Drive in Jet Dyeing Machine

Problem: In Jet Dyeing higher pressure of 3.5 kg/cm^2 is required to ensure uniform dyeing of the fabric and also causes fabric movement whereas lower pressure of 1.5 kg/cm^2 is required for creating movement of the fabric during cycle other than dyeing cycle. Due to non-availability of any mechanism for varying the pressure, the pump is made to operate on much more than the required pressure or is throttled to get the required pressure. In case of operating at higher pressure, electricity is unnecessarily wasted.

Pilot measure: The system proposed is retro fitment of a VFD armed with PLC based control gear to the Jet Dyeing Machine so as to implement time based and requirement oriented change in RPM of the pump. The PLC based system can be integrated with existing control gear or can be installed as a package.

Benefits:

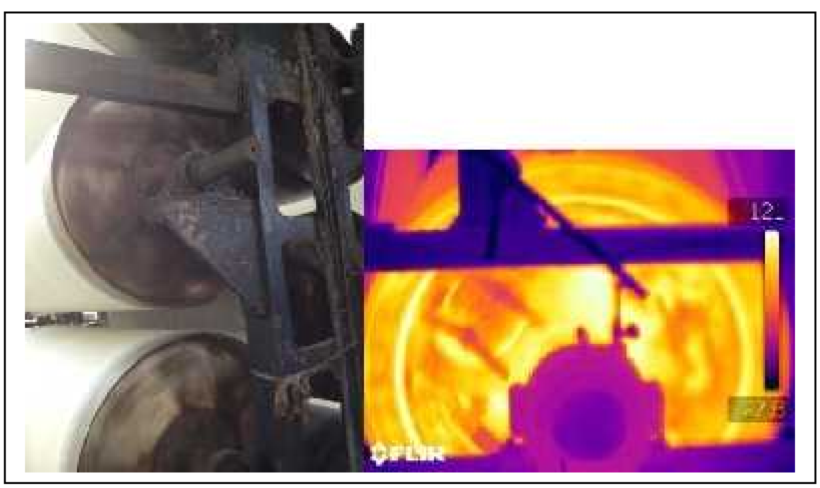
- Reduction in electricity consumption
- Better process control

Cost benefit analysis: Capital cost of one 12.5 HP VFD is USD 468.75, operating costs is negligible, giving total savings of USD 859.37 per annum with return of investments of 7 months.

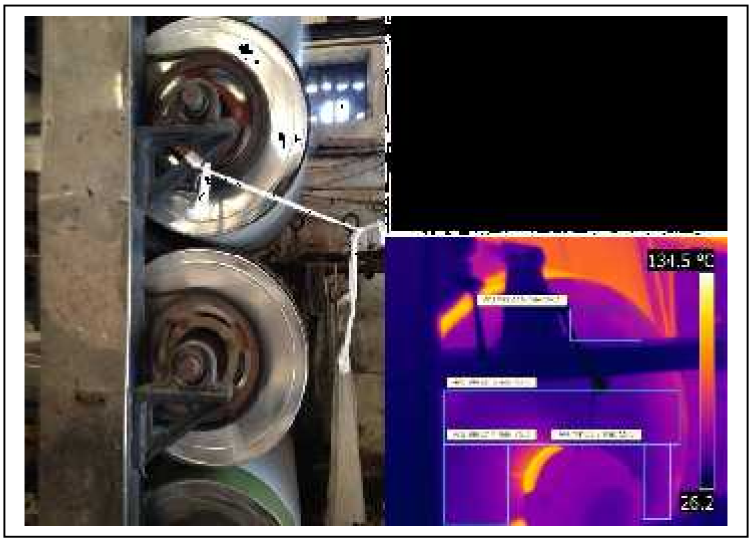
Case Study: No: 11 Heat Losses Optimisation at Cylinder Drying Range

Problem: A typical 16 cylinder dryer requires 110 kg steam input per hour for 2400 m/hr fabric running rate, i.e., approximately 0.30 kg of steam per kg of water evaporated. The side plates of cylinders, non-covered cylinder surfaces and non-isolated piping emit heat to the surrounding area and thus loss of energy. The major challenges for insulating the side plates of a cylinder dryer are following:

- Cylinder dryers rotates at 50-60 rpm
- Normally industries insulate with glass/mineral wool
- Water resistance of mineral wool is very low and thus gaining moisture by insulation makes it conductive to heat loss
- Normally insulation peel off within 2-3 month of installation
- Due to low moisture resistance and holding of moisture within insulation promotes corrosion



Pilot measure: Side plates of drying range can be insulated with more durable (life & properties) mineral/rock wool, which can result in reduction of steam consumption. This non-combustible mineral wool is a composition of inorganic components which are melted in a furnace, and then spun and bonded with a resin to form various insulation products. Mineral wool comes in various forms. Meter sections come in preformed sections and vary in density from 160 kg/m^3 to 185 kg/m^3, depending on the pipe size. The Wired Mattress, rigid and semi-rigid board and flexible felt comes in a matt form, or reinforced mat depending on the requirements.



Also, there are heat resistive coatings available in market which are polymer based coatings with special thermal insulation properties and are applicable for the hot surfaces where the installation of conventional insulation is not practical due to various reasons. These heat resistive coatings claims reduction of heat losses upto 20 % and surface temperature reduction upto 40 %.

Benefits:

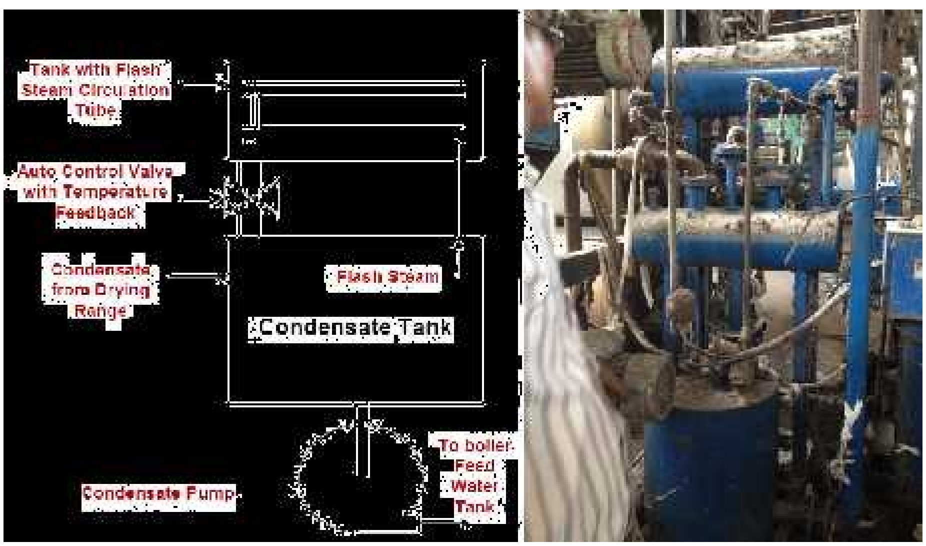
- Reduction in steam consumption: 5-10%
- Reduction in boiler emissions.
- Production area working conditions will improve
- Safety for workers will improve

Cost benefit analysis: Capital costs of the insulation will be USD 546.87 for 12 m^2 surface area, No operating costs involved and estimated saving is USD 1812.5 with payback period of 4 months.

Case Study: No: 12 Flash Steam Recovery of Drying Range to Preheat Boiler Feed Water

Problem: A typical dryer machine has 12 to over 30 steam cylinders. A typical 16 cylinder dryer requires 110 kg steam input per hour for 2400 m/hr fabric running rate, i.e., approximately 0.30 kg of steam per kg of water evaporated. The steam after condensation comes out of the dryer cylinder at approx. 2 kg/cm^{2}g pressure which then is collected in an open tank, due to sudden change in pressure some of the heat from condensate is used to evaporate water and thus generation of flash steam. This flash steam goes into atmosphere as waste. The industry is having 4 nos. of drying ranges with average 45 KL/day condensate generation from each range.

Pilot measure: The industry designed a simple system to recover this flash steam and raise the temperature of boiler feed water to reduce the fuel input at boiler by supplying heated water. A additional tank is constructed above the condensate recovery tank and flash steam generated is allowed to be passed through coils in the top tank to heat the water, when the water temperature reaches the required feed water temperature an automatic valve opens the flow to condensate tank and the heated water with hot condensate is pumped to the boiler feed water tank.



Benefits:

- Reduction in coal consumption by 510 tons per year.
- Reduction in fresh water consumption of 3375 KL per year due to recovery of flash steam
- Reduced emissions from boiler

Cost benefit analysis: Capital cost for the modification was USD 1562.5 with savings due to reduction in fuel consumption of USD 55734.3 per annum with negligible operating cost giving payback period of 10 days.

Case Study: No: 13 Efficient Boiler Operation

Problem: Boiler efficiencies will vary over a wide range, depending on a great variety of factors and conditions. The highest efficiencies that have been secured with coal are in the range of 50-82%. It is being observed that the combustion efficiency of the boiler is lower than the current standard boilers delivering, the combustion efficiency of the boiler was found to be only 80 % while the combustion efficiency of efficient boilers is more than 90 %. The reasons for low combustion efficiency are:

The heat transfer is poor due to low heat transfer area and short contact time between flue gas and the water.
The fuel charging door remains more or less open during the entire operation due to various reasons, mostly human errors. There is no control over fuel firing in combustion chamber

Pilot measures: After detailed investigation industry has decided to replace the existing boiler which is not efficient with the efficient 6 TPH capacity boiler with ESP system to take care the air emissions as well. The performance of the existing boiler was evaluated and comparison with the efficient boiler for same amount of steam generation was carried out, on the basis of calculations industry placed the order for new boiler.

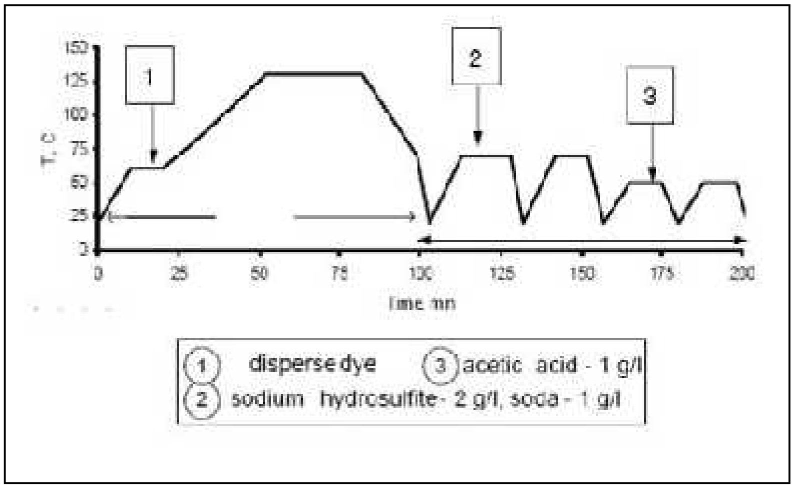
Benefits:

- Reduction in coal consumption: 10-30%
- Reduction in boiler emissions.

Cost benefit analysis: The capital cost of the boiler is Approx. USD 132812.5 (excluding ESP), while the operating cost remains the same while it will reduce due to consideration of latest technologies and control of the boiler system, the total estimated savings of USD 78125 giving payback period of 21 months.

Case Study: No: 14 Batch Washing in Place of Continuous Washing in Jet Dyeing Machine

Problem: In Jet Dyeing Machine, the washing is carried out with continuous flow of fresh water in order to remove the unexhausted dyes and chemicals without any control. During continuous washing 5000 litre / batch of water is consumed without any real requirement and as a normal practice.



Pilot measure: Batch / Intermittent washing is applied with fresh water intake of three cycles in batch manner instead of continuous flow of water. Achieved by giving appropriate instruction to dyeing master and & operating staff.

Benefits:

The same washing quality is achieved in batch washing with 3500 litre / batch of water.

Cost benefits analysis:

The reduction in water consumption was approx. 39600 KL per annum on 11 nos. machine without any capital cost or operating costs, with saving of USD 4765.62 per annum (pumping cost only) with immediate return.

Case Study: No: 15 Auto Colour Dispensing through Spectrophotometer & Chemical Dispensing System

Problem: The correlation between the formula developed in the lab and the formula used in production cannot be done manually thus resulting in excess chemical usage and increased rework. Reproducing colour accurately and cost-effectively in all of these instances is difficult. Number of problems associated with using traditional manual methods of preparing solutions is as following:

- Errors can occur when manually calculating the amount of dyestuff, auxiliary and water required when making up solutions.
- Manually weighing out the precise amount of the required dye takes time and skill, and the risk of mistakes in a busy production environment is high.
- Manually dispensing auxiliaries and water accurately is very time consuming.
- Variations in the temperature of water used can affect the stability and accuracy of solutions for certain dyestuffs.
- Inaccuracies in the amount of auxiliary added in solutions can affect the stability and reliability of solutions for certain dyestuffs

Pilot measures: An infrared exhaust laboratory-dyeing machine with a fully automated dosing system. Once the on-screen colour is created, the software then, in turn, automatically computes the right colorimetric data. This is the digital "signature" of that colour - and includes the standard colorimetric parameters such as reflectance and L, a, b data. The system accepts measurements from a spectrophotometer in the form of colorimetric data, and instantly transforms that data into visual colour on the screen for evaluation or adjustment.

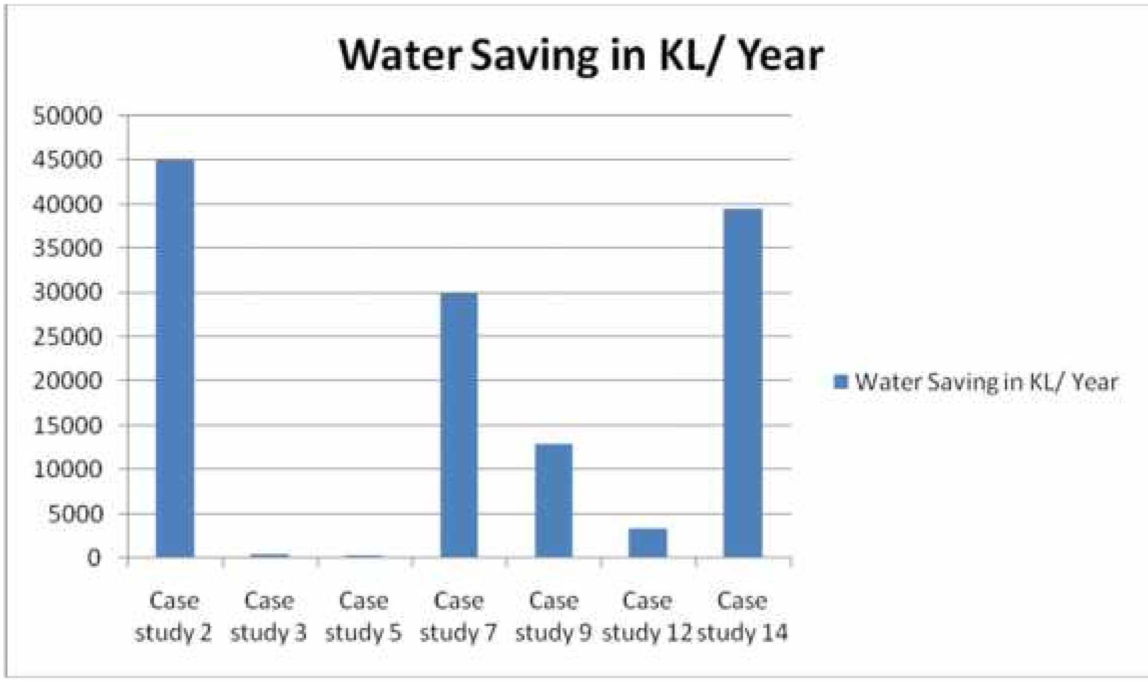
Perfect stock solutions require perfect dispensing of chemicals to machine and thus automated chemical dosing system was installed for production machines.

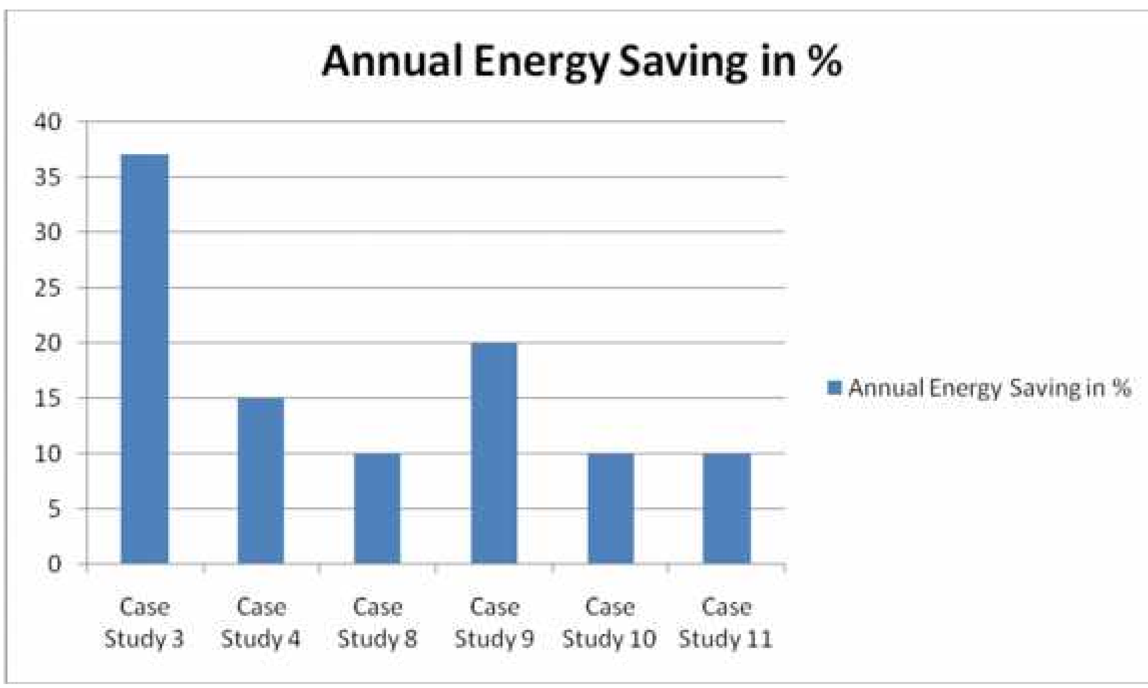
Benefits:

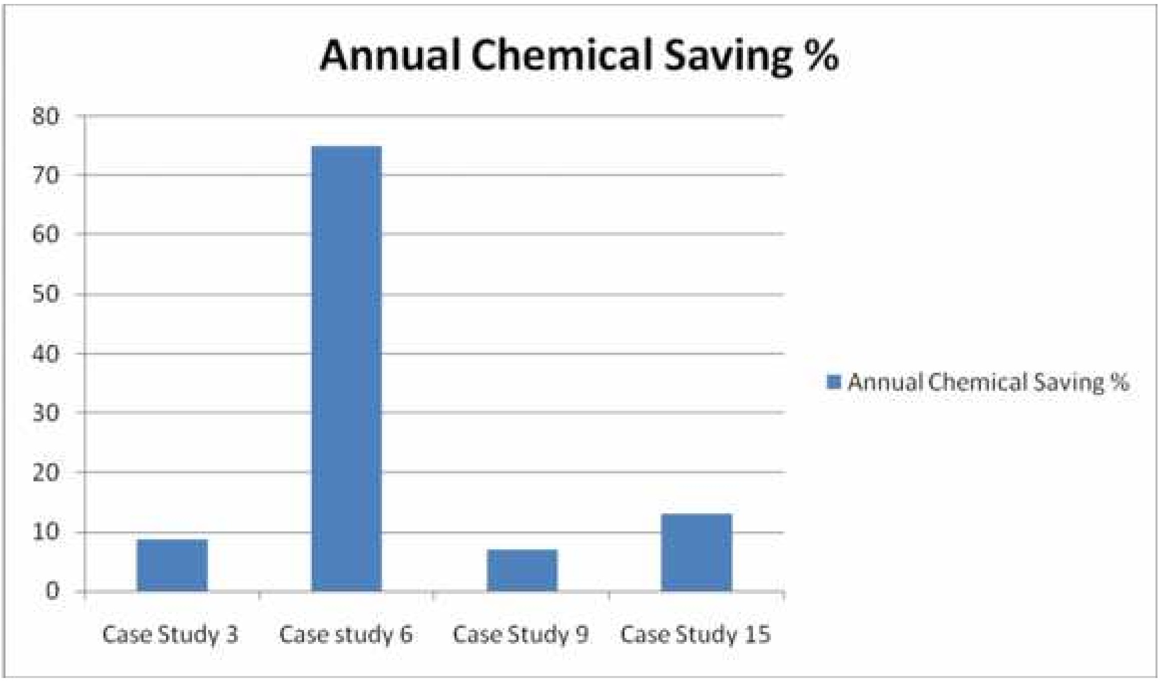
- These systems reduce the tendency to overuse environmentally harmful chemicals and, therefore, reduce pollutant loads of discharged effluents. They also reduce handling loss and equipment clean up. In addition, they improve the efficiency and reliability of chemical reactions in the dye bath, ensuring consistent and reproducible results.
- It reduces chemical usage (excluding dyes) by at least ten 10 % and rework of fabric by 3 %. It also reduces labour and overhead costs, increases production, and eliminates the manual handling of chemicals.

Cost benefit analysis: The capital cost invested by industry was USD 312500, with minimum operating and maintenance cost, the total savings achieved by industry is USD 97875 per annum giving simple payback of 3.5 years.

Results at a glance







Success Areas

The results were achieved through the implementation of the following measures:

- Reduction of CETP / disposal charges for the volume of waste water reduced
- Water consumption reduction
- Chemical & auxiliaries consumption reduction
- Electrical power consumption reduction
- In one case, the total boiler feed water is being now catered by recovered condensate & cooling water.
- Boiler feed water consumption reduction
- Recovery of energy in form of heat from hot water
- Reduction in boiler emissions
- Reduction in waste water generation (quality & quantity)
- Reduction in effluent generation due to reuse of cooling water
- Chemical (Caustic) consumption reduction
- Reduction in coal consumption
- Reduction in thermic fluid heater emissions
- Reduction in process time
- Better process control
- Reduction in steam consumption
- Production area working conditions will improve
- Safety for workers will improve
- Reduction in fresh water consumption due to recovery of flash steam
- The same washing quality is achieved by batch washing instead of continuous washing
- These systems reduce the tendency to overuse environmentally harmful chemicals and, therefore, reduce pollutant loads of discharged effluents. They also reduce handling loss and

equipment clean up. In addition, they improve the efficiency and reliability of chemical reactions in the dye bath, ensuring consistent and reproducible results.

- Reduces labour and overhead costs, increases production, and eliminates the manual handling of chemicals.

Resource Efficient and Cleaner Production (RECP)

Table 2: Options implemented

Principal Options Implemented	Benefits			
	Economic		Resource Use	Pollution generated
	Investment [USD]	Cost Saving [USD/yr]	Reductions in energy use, water use and/or materials use (per annum)	Reductions in waste water, air emissions and/or waste generation (per annum)
Reuse of Alkaline Stream from Mercerising	USD 7812.5	USD 8437.5	Caustic Consumption: 15000 kg	
Reuse of Treated Water for Washing at Printing Machines	USD 4687.5 + USD 1343.75 pumps operating cost	USD 4031.25	fresh water consumption: 150 KL per day	
Replacement of alkaline scouring with bio-scouring enzyme for enzymatic scouring	Chemical Change	USD 78468.75	Water : 45.45% Chemical: 8.65% Electrical power : 37.04% Fuel (coal): 24.55%	

Recycle/reuse of cooling water and condensate water as boiler feed water	USD 4687.5 + USD 4890.62 pumps operation of 10 HP transfer amount	USD 51562.5	Boiler feed water: 100% Recovery of energy in form of heat from hot water: 15%	Reduction in boiler emissions Reduction in waste water generation (quality & quantity)
	USD 17187.5 + USD 3062.5 pumps operation of 10 HP transfer amount	USD 18937.5		
Water Consumption Optimization at Jigger Machines	USD 3125 per jigger	Water : 360 KL per year	water : 360 KL per year	Reduction in effluent generation due to reuse of cooling water.
Caustic Soda Recovery System	USD 144375 + USD 75328.12 operating cost	USD 221875	Chemical (Caustic) : 75%	Reduction in waste water generation (quality & quantity)
Optimization of Heat Energy in Jigger Machines	USD 21093.75	USD 13593.75	Coal : 102 tons Fresh water: 30000 KL	Reduced emissions from boiler
Optimization of Exhausts by Controlling the Exhaust Humidity with Automation	USD 2578.12	USD 2890.62	Electrical power: 5-10% Fuel (coal): 20%	Reduction in thermic fluid heater emissions.
Low Liquor Ratio Jet Dyeing Machines	USD 195312.5	USD 29531.25	Water: 30% Electrical power: 20% Fuel (coal): 30% Reduced consumption of chemicals & auxiliaries.	Reduction in waste water generation (quality & quantity)
Installation of Variable	USD 468.75	USD 859.37	Reduction in	

Frequency Drive in Jet Dyeing Machine	per one 12.5 HP VFD		electricity consumption	
Heat Losses Optimization at Cylinder Drying Range	USD 546.87	USD 1812.5	Steam: 5-10%	Reduction in boiler emissions.
Flash Steam Recovery of Drying Range to Preheat Boiler Feed Water	USD 1562.5	USD 55734.3	Coal: 510 tons Fresh water: 3375 KL	Reduced emissions from boiler
Efficient Boiler Operation	USD 132812.5	USD 78125	Coal: 10-30%	Reduction in boiler emissions.
Batch Washing in Place of Continuous Washing in Jet Dyeing Machine	Reduction in water consumption approx. 39600 per annum	USD 4765.62	Fresh water: 39600 KL	
Auto Colour Dispensing through Spectrophotometer & Chemical Dispensing System	USD 312500	USD 97875	Chemical usage (excluding dyes): 10 % and rework of fabric: 3 %.	

Approach taken

The overall objective of the programme is to facilitate promotion of Best Available Techniques (BAT) without entailing excessive cost in various industry sectors in Textile Sector in Gujarat so as to strengthen environmental management and pollution control in the industries in these sectors. The following actions were designed:

1. Capacities of identified stakeholders are strengthened in terms of knowledge and skills of the involved staff that are mandated with facilitating environmental improvements in industries.
2. Knowledgebase strengthened in India by using BREF documents as well as exchange of knowledge and experiences from Germany.
3. Customized reference documents developed for Gujarat for identified industry sectors.
4. Pilot measures demonstrated in identified industries/sectors.
5. Dialogue promoted among various stakeholders and voluntary commitments are promoted.
6. Increased knowledge of industry, regulatory authorities and other stakeholders on BAT for facilitating improvements in industries.

Business case

Best available techniques means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and where that is not practicable, to reduce emissions and the impact on the environment as a whole.

Testimony Box
Gujarat Cleaner Production Centre (GCPC)
The Gujarat Cleaner Production Centre (GCPC) has been established by Industries & Mines Department, Govt. of Gujarat under Gujarat Industrial Development Corporation (GIDC) in the year 1998 with technical guidance of UNIDO and since then the centre is actively engaged in the promotion of Cleaner Production (CP)/Clean Technology (CT) through its various activities such as orientation/awareness programmes, CP and CT Assessment Projects etc. Contributions of GCPC over the years towards promotion of Cleaner Production in the state of Gujarat to improve the productivity and the environmental problems faced by SMEs have been significant. GCPC had also played active role in framing Industrial Policy 2003, 2004, 2009 and 2015, also supported in developing many financial assistance schemes pertaining to CP/CT. GCPC is also member of RECP of UNIDO and Climate Technology Centre and Network (CTCN), a working arm of UNFCCC. GCPC have so far conducted more than **200 Orientation Programmes** in different colleges, organizations and industries associations. The centre has successfully completed more than **100 CP Demonstration Projects** in various sectors like Textile, Dairy, Pulp & Paper, Chemical, Petrochemical, Pharmaceutical, Fish Processing, Ceramic etc.
Contact Details
Dr. Bharat Jain Member Secretary Gujarat Cleaner Production Centre Block No: 11-12, 3rd Floor, Udhyog Bhavan, Gandhinagar, Gujarat (India) Phone: + 91 79 232 44 147 Mail: gcpc11@yahoo.com, info@gcpcgujarat.org.in URL: www.gcpcgujarat.org.in
English Abstract (where applicable)
N/A