A Review On Cleaner Technology In Pollution Control At Ultra-Red Industry In Tamil Nadu, India

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Abstract: The study focuses on qualitative review of literature in cleaner technology usage in large-scale Ultra-red firms classified as 17 (highly polluting industry) in Tamil Nadu, India. Its state the efficacy between the older end of pipe and modern technology like reuse, recycle, raw material usage, add-on, process change, co-processing and energy conservation relevance to pollution control agency contribution in up-gradation and promoting technology by setting up regulation policy, intuitional background and research and development. The outcome is still India has to promote in a higher diffusion of self-reliance in product manufacturing (intellectual property rights) improve in research and development, strengthening the regulation policy.

Key word: Cleaner technology, Ultra-Red industry, large scale industry, Audit, environmental management system and energy management system.

Introduction

Cleaner production-defined as the continuous use of industrial processes and products to prevent the pollution of air, water and land, reduce wastes at source, and minimize risks to the human (UNEP 1994). Industrial pollution is one of the serious environmental problems in India. Industrial pollution control policies from 1974 till date, have attempted to abate pollution through regulatory mechanism. Regulatory method has were not much effective in controlling pollution from industries .An alternative to regulatory mechanism is market instruments started to accept influence in supplementing the existing regulatory rules. Even market instruments could not bring industrial pollution to a complete halt .In this millennium cleaner technology, greener technology came into the one and a half decade in India. According to the department of central pollution control board, there are about 2522 of large and medium scale industries in ultra-red category 17 (CPCB CREP, 2003, 2016) and different manufacturing products out of this data reveals that only 71 percent of the total industries in the 17 categories have adequate pollution control facilities to make sure compliance with regulations found defaulting with respect to pollution control (CPCB, ENVIS, 2011). The remaining industries have been found to be in non-compliance with regulations mandating pollution technology, out of which 478 units have been closed down (CPCB,ENVIS, 2011), due to ineffective pollution control, now the CPCB and India planning commission meet in 2011 has set an objective to bring "Rapid Ecologically Sustainable development" (Jamsyhd Godrej, Naushad Forbes,2011) Industrial Growth has proposed to Check off large and medium scale industries using "Clean or green technology on setting up continuous emission/effluent monitoring on real-time data technologies it has been a mandatory. However, the efficiency of cleaner technology is yet to be studied in systematic way. Hence this study is qualitative data (review literature to analysis the status of pollution controlling Industries in large-scale (ultra-red category) industry in Tamil Nadu and India.

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Problem setting

Industrial pollution control is a vogue ever since pollution control policies carried into enforcement. Technological advancement has brought modern and sophisticated technologies on the one hand and the corollary effects on the environment on the other. Pollution control with end-of-pipe technology (EOP) showed some success initially. Later in the recent period, end of pipe technology proved to be ineffective due to myriad reasons. A technology which can supplement the existing end-of-pipe technology is thought of in the name of cleaner technology. What is the status of cleaner technology in Tamil Nadu and India? What is the proposition of industrial units started to take to cleaner technology? How effective is this technology? Do research and development faculty for promoting cleaner technology in India? Do environmental protection agencies give importance in upgrading regulation policy in cleaner technology? Whether or not cleaner technologies help achieving win-win situation? Do large scale industries are adopting and upgrading cleaner technology? There is some of the research question yet to be answered.

Objective

The aim of this paper is to discern the Indian experience especially fresh policies relevant to technology which are given by environmental protection agencies. This paper includes the experiences of Ultra-red (highly polluting) large-scale industry around India and Tamil Nadu which have efficiently implemented cleaner technologies.

Material and methods

This paper relies on secondary data sources; research and review articles, books, newsletters and various national and state organization reports for the review of literature. Attempts, however, were made by the authors to gather primary information from a few industrial units in Tamil Nadu and all over India, but in vain due to reluctance from the industrial units to divulge information. Hence secondary, published sources were resorted to understand genesis of clean technologies and growth over the period.

Table.1: Review of Cleaner technology adoption in large-scale industry in India.

S.no	Author & year	Industry	Clean technology	Advantage
1.	Chandak, 1994	Agro-residue based pulp & paper, textile dyeing & printing and pesticide	450 waste minimization options	Savings of 35.8 million (US$ 1.2 million) and a significant pollution load reduction in all sectors
2.	Kumar et. al., 1998	Brick kiln	Vertical Shaft Brick Kiln technology (VSBK)	Energy conservation
3.	Mohanty et. al., 1998	Cement industry	Vertical roller mill	Energy saving
4.	TERI, Information Monitor, 1999	Textile industry	Dye stuffs and rayon	Filtering process
5.	CPCB notification, 2000	Chemical	Sludge-Reagent-Product (SRP) Technology	90-95 percent recovery of chemical coagulant (alum) for treating the water increased eco-efficiency with both economic and environmental benefit
6.	Saha, 2004	Distillery	Optimization of cooling tower operation	(Semi-continuous/continuous fermentation could reduce water use.
7.	CPCB, 2004	Tannery	Vegetable tanning	Lesser the amount of odour H_2S
8.	Gujarat cleaner production center (GCPC) 2010	Chemical, Dye and dye intermediates, Cement, Paper and pulp, Sugar, Tannery industry	Recovery, Reuse ,Recycling and energy conservation technology	Techono-eonomic and cost effective system creating instructions background
10.	Sengupta, 2011	Thermal power plant	Fly ash management system	Lesser the amount of air pollution (Adsorption)
11.	Comprehensive, industrial pollution index, 2012	To Identified as critically polluted.	To adopt technological up-gradation in small, medium and large	CPCB has done a nationwide environmental assessment of Industrial Clusters based on CEPI and 43 such industrial clusters having CEPI greater than 70.
12.	GCPC(Gujarat cleaner production center) 2013	Pharamautical industry	minimizing the generation of wastes raw material use	CP opportunities are identified. Unit was able to benefit annually by about INR 10, 14,240 through the implementation of CP solutions, with an investment of INR 6, 57,550.Narol, Odha, and Vatva.
13.	Ken L. Mok et.al.,2014	steel and iron, smelter, chlor alkali, cement and paper and pulp, thermal power ,oil refinery, petro-chemical industry	Energy- Conservation	Greenhouse gas emission Energy in higher potential to lower down this Kyoto protocol came into an extent which originated " Clean development mechanism" (CDM).
14.	CPCB, 2015	Iron and steel (inter power plant)	Base blending, cokeing	Reduction of heat and conservation of energy
15.	CPCB, 2015	High water polluting industries	Membrane technology (MGF,ASP,UF,NF,USAB,RO,USBR)	Advanced treatment process (Zero liquid discharge)
16.	CPCB, 2016	Every Industry for pollution control	Real time pollution monitoring system	Online monitoring system in every industries for water, air and Hazardous waste management system
17.	ENVIS, 2017	Industrial Pollution control database	Recycling, reusing, reducing, Co-processing, Co-generation, Industrial ecology and Hazardous wastes management system and real time monitoring system	The database has a collection of data on the past and future technology on industrial pollution control, it develop a paradigm to research and development and has been a tie up with other state and international institutes.
18.	BAT,OECD 2018	Processing of non-ferrous metals (hereafter 'non-ferrous metals') pre-treatment (operations such as washing, bleaching, mercerisation)	Advance technology for controlling air and water pollution	To have research and development background with CPCB on sharing of knowledge

		or dyeing of textile fibres or textiles (hereafter 'textiles')and production of pulp and paper (hereafter 'pulp and paper').		
19.	Gujarat cleaner production centre (GCPC)2019	Chemical, Pharmauctical waste, oil refine nary, ceramic and sludge	Recovery, co-processing and energy conservation	About 19 different classification industry has taken project under the GCPC scheme

Indian scenario adopting cleaner technology

Indian economy is being influenced by international economy for the past two decades as a result of the amendment in its approach to open up for international participation by initiatives that followed after the launching of latest policy in 1991 (Economic policy, 1991). In order to vie higher within the international business arena the country has been adapting several modern from older technological contributions generated worldwide. India has been adapting too many environment laws and initiatives of global standards since Stockholm's conference in 1972. The initiatives were the Water (Prevention and management of Pollution) Act, 1974, followed by the Air (Prevention and Control of Pollution) Act, 1981. India has been initiating several laws and acts to make sure property efforts and compulsions to mitigate environmental issues. In 1994 National cleaner production center (NCPC) was initiated with the shibboleth of developing and introducing clean production practices in SMEs (Small and medium enterprises) in Asian nation as a result of SMEs contribute in large scale in the pollution dispersions. Demonstrations in small industries for reducing waste (DISIRE) were initiated by NCPC in 1994 (UNIDO, 2002). A large variety of business units discharge their effluents into rivers associate degreed lakes in an unsafe manner making higher level of stress to the atmosphere. CPCB has listed altogether eighty eight styles of polluting industries (Comprehensive Environmental Assessment of Industrial Clusters, 2009). 17 industries as red category and vigilant monitoring have been introduced for those industries. In India eighty eighty "critically pollution zones" (CEPI, 2009). Indian environment policy framework introduced in 1992 has proposed an approach to integrate environment aspects in development planning, preventive measures for industrial pollution control.

Table.2: Review of Cleaner technology adoption in large scale industry in Tamil Nadu

S.no	Author & year	Industry	Clean technology	Advantage
1.	TNPCB, 2003	Caustic soda	Recycling technology	Several industrial units in Tamil Nadu have switched over to cleaner technologies such as; Adoption of membrane cell process replacing mercury cell process in caustic soda manufacturing.
2.	Chinnaraj, 2003	Pulp and paper	Energy conservation	Bio-methanation plant generated 59 lakhs cubic metres of methane gas enabling the company to save consumption of 3,545 KL of furnace oil. Which generates around 23000 m^3 of biogas (methane) per day, to be used as fuel in the lime-kiln in replacement of furnace oil.
3.	TNPCB, 2004	Cement	Co-processing	About 50,000 Tonnes of ETP sludge have been disposed to various Cement industries for co-processing. Similar trails are being taken-up for using hazardous waste generated from tannery CETPs.
4.	TNPCB, 2007	Sago	Energy conservation	Sago units recover methane gas from their trade effluent through anaerobic digestion. Activated carbon manufacturing units have gone for waste heat recovery boiler and eliminated the dedicated boiler to produce steam for the activation purpose.
5.	TNPCB, 2010	Chemical and paint	Recycling technology	Cuddalore SIPCOT industrial estate in 8 industries such as Clariant chemicals, TANFAC industries, Asian paints, Pandian chemicals, chemplastsanmar, Tagore chemicals, shasun chemicals, SPIC Ltd, Pioneer jellicelow and advance cleaner technology are used to control air pollution at the process itself dry scrubber, coal to biofuel, Bio-filter modification, solvent recovery systems. Reduction of VOC like chloroform, stabilization of waste, double drum dryer.
6.	Hindu, 2013	Textiles and Tannery waste	Recycling	Veerapandi Common Effluent Treatment Plant (CETP) in Tirupur for using the sludge. The ACC had used 3,500 tonnes of sludge from the CETP. It had agreements with three individual effluent treatment plants (textiles) too and used the sludge from these plants. So far, it had used 4,254 tonnes of sludge.
7	NLC annual report, 2013	Coal (NLC)	Flue sulphurization for air-pollution control	Low Cost ash removal technology from Coal and promotion of Clean Coal Technologies (IGCC, PFBC), Aluminum Industries using Soderberg Technology. Low Cost Flue Gas De-sulphurisation Technology.
8	TANGEDCO, 2013	Sugar	Energy conservation	In Tamil Nadu, there are 16 cogeneration plants bagasses has a raw material with 274.6 MW and their contribution to TNEB grid is 155 MW in season and 168 MW during off season.

9	Chettinad cement industrial report, 2014	Cement	Energy conservation	Generation of Power through Waste Heat Recovery Boiler from Waste Hot Gases 8MW, Captive power plant is 115.74 Ha.
10	Seshasayee Paper annual report, 2016	Paper industry	Energy conservation	Spouted fluidized bed, Black liquor solid co-gen, chemical recovery boiler with 16 MW Turbo alternators working at 100 percent green fuel. Non-Conventional Source of Energy wind power generation, co-generation, solar water and air heating systems and bio-gas plants, improved challahs etc., have been remarkable. The renewable energy sources have contributed more than 770 MW of power to the installed capacity of the state.
11	TNPCB, 2016	Textile	Zero liquid discharge facility	Status in Textile Bleaching and Dyeing Industries CETPs 468 units 1, 02,100 Capacity of the Plant in KLD.
12	TNPCB, 2016	Technology Demonstration Centre	Upgrading technology	Holistic technology (institutional background)
13	TNPCB, 2017	Tannery	Zero liquid discharge facility	13 CETP schemes established for tanneries, 11 CETPs with ZLD
14	TNPCB, 2018	Cement	Recycling	Cement industries such as A.C.C, Madukarai and Grasim Industries; have taken trial runs for utilizing paint sludge, Tar waste, Petroleum refinery sludge as incineration material.
15	TNPCB, 2018	Oil and refinery	Recycling	List of authorized waste oil recyclers 12 List of authorized used oil recyclers authorized 26 industries in manufactures authorized non-ferrous waste, zinc, copper scrap recyclers.

Scenario of cleaner technology in Tamil Nadu

Tamil Nadu has sources of raw material usages like coal, gypsum calcium, largest producers of sugar cane and distillery Bagasse, steel, refineries, petroleum and by-product, paper mill with usage of bagasse, textiles, smelters about 193 large scale (Ultra-red) polluting industries (TNPCB, 2019), in every industry there is a recycle and advance technology. In Tamil Nadu about 6.91 lakhs tons of hazardous waste is generated per year in which 2.97 lakhs tones is land fillable, 3.42 lakhs tones is recyclable and 0.52 lakhs tones is incinerable. The Board is taking steps in handling and management of hazardous wastes, its treatment and disposal in an environmentally safe manner. One common hazardous waste Treatment Storage and Disposal Facility (TSDF) has been established in SIPCOT Industrial Estate, Gummidipoondi and it is in operation. Efforts to utilize the hazardous waste generated from Common Effluent Treatment Plants (CETPs) of textile processing units as fuel/raw material for co-processing in the cement factories. So far, about 50,000 Tonnes of ETP sludge have been disposed to various Cement industries for co-processing (TNPCB, 2018). There are 3,545 units generating hazardous wastes and issued authorization under the rules. In about 560 tannery industries in 13 Common effluent treatment plant (CETP) 11 Zero liquid discharge (ZLD) are in operation in Vellore Erode Pallavaram Dindigul Trichy Madhavaram of 23,712 KLD and two are in progress (TNPCB, 2016). Oil Refinery Present oily sludge generation from 12 oil refineries are about 65000 tonnes per annum. In few refineries only, remediation of oily sludge is practiced. 468 Textile Bleaching And Dyeing Industries have 30 Common effluent treatment plant (CETP) 29 Zero liquid discharge (ZLD) are in operation inTiruppur, Karur, Perundurai, Ayyampettai 0f 1,02,100 KLD and one are in progress (TNPCB, 2016).Salem steel authority Blast furnace slag from steel industry should be granulated and used for cement making (CLRI, 2016) List of 26 metal and SIDCO authorized non-ferrous waste, zinc, copper scrap recyclers and List of 14 authorized used oil recyclers and 12 authorized waste oil recyclers in refinery industry In 189 ultra-red category industry in Tamil Nadu 57 major industrial units have the ISO-14001(EMS),ISO-9001(QMS) and ISO-50001 (EnMS) certifications which are awarded by an external agency after auditing the environmental management systems. TNPL is the largest paper mill in India with an installed capacity of 600 tonnes per day new print consist of 85 percent of Bagasse and 15 percent of hardwood and pulp is manufactured from 75 percent of bagasse and 25 percent of hardwood chemical pulp, de-inking plant and captive energy processing (TNPL annual report, 2018).

Scenario of Water Pollution industries in India

Waste-water generation from industry has been estimated to be 55,000 million m^3 per day, of which 68.5 million m^3 are dumped directly into Local Rivers and streams without prior water treatment (Rajaram and Ashutosh 2008) (planning commission, 2011). CREP Corporate responsibility for environmental protection has given certain industries in highly water polluting industry Distillery, Sugar, Textiles, Tannery, Thermal power plant, Paper and Pulp and Dyes and dye intermediates. CPCB has given a list of advanced water treatment technology (Membrane filtration (MF), Reverse osmosis (R.O), Micro-filter (MF), Nano-filtration (NF), Ultra-filtration (UF), up-flow anaerobic sludge blanket rector (UASBR). Bio reactor, Multiple Effect evaporator (MEE), (USAB) Electro dialysis, ZLD for wastewater treatment process to achieve zero liquid discharge (ZLD) (CPCB, 2015).

Scenario of High energy consumption and air pollution industry in India

The Central Pollution Control Board (CPCB) has identified seventeen categories of industries (large and medium scale) as significantly polluting and the list includes highly air polluting industries such as integrated iron and steel, thermal power plants, copper/zinc/aluminum smelters, cement, oil refineries, petrochemicals, pesticides and fertilizer units. Air borne emissions emitted from various industries are a cause of major concern. There are about 43 critically air polluted industrial areas in India All these factors are related with high-energy consumption level that leads to environmental problems in (Industries like Aluminum smelter, copper smelter, iron and steel, cement,

paper and pulp, fertilizer industries (Sengupta, 2013). (CEPI, 2013) Most of these large/medium scale industries are more energy intensive and consume millions of tonnes of Soild /liquid/gaseous fuels and emit considerable quantity of (SO_2, (Oxides of nitrogen)NO_X,CO(Carbon monoxide),HC (hydrocarbon),RSPM (Respirable suspended particulate matter), Chlorine Cl_2, Ammonia NH_3,Pb (Lead),(Particulate matter PM_{10}) persistent organic pollutants (POP),(Tamhane,2008) persistent bio accumulative toxic chemical (PBTs),Volatile organic compounds (VOC) Mercury (Hg), Polycyclic Aromatic Hydrocarbon (PAH),(Thacker, 2008). Unless they are effectively controlled by control strategies to include the use of dust control system like cyclones, multi cyclones, ESP, scrubber, and bag filter and water spray for dust suppression.(NAAQS), National Ambient Air Quality Standards is the National air quality monitoring agency.(Thacker 2008, Anjali 2008).

State-of-art technology used in large scale highly polluting (Red category industry)

Cement industry: Low carbon technology, Co-generation, co-processing of Tannery ETP sludge in the cement kiln to utilize 3000 Tonnes of tannery (ETP) sludge using various proportions 1 percent, 1.5 percent and 2 percent (CPCB, 2009), variable frequency drive (VFD), Energy saving in auxiliary instrument (Co-processing notification CPCB, 2010) are used in cement industry for energy optimization like vertical shaft kiln technology (Sengupta, 2002, 2010). Hence Steel Authority of India Ltd., (SAIL) has switched from end-of-pipe technology to cleaner production to enhance their environmental performance (GCPC,2010).

Petrochemical industry: use of Central Vacuum system for source reduction of oily sludge, installation of vent filters on FCC catalyst hoppers, recovery of phenolic from spent caustics on Site through acidification and phase separation, recycling spent alumina catalyst as raw material for alumina-based products are used. (Freeman, 1995).Thermic fluid heaters, polymerization Fume Scrubber, Aspiration filter, Volatile Organic Compound - Flare gas vent, Gas Sensors, Caustic Fusion Plant - Automatic Built in Air/Fuel Ration control, Captive Power Plant - Automatic Built are also used (CPCB, 2003, GCPC,2015).

Textiles: Alternate dyes like copper-free for producing green shades, use of alternate de-sizing agents (enzymes that degrade starch ethanol), and (Membrane filtration (MF), Reverse osmosis (R.O), Micro-filter (MF), Nano-filtration(NF), Ultra-filtration (UF), Electro dialysis, ZLD for wastewater treatment process (CPCB notification, 2007,2015) and Lime mud washing in caustizer plant are frequently used in these industries (GCPC, 2010).

Pharmaceuticals: Substitution of isopropyl acetates for toluene and implementation of recovery
Schemes; replacement of two-solvent extraction system with a single environmentally more benign solvent, Bio reactor, Multiple Effect evaporator, Composting yard, Sludge drying beds, Ultra filtration unit. Nano filter, and (Reverse osmosis) R.O. Plant are used in such industries (CPCB, 2015 GCPC-ENVIS 2015).

Paper and Pulp Industries: Several cleaner technology mechanisms such as bacterial pellets to control odor; extended delignification; use of deformers; steam stripping of foul condensates; use of weak wash for scrubbing fluids in air pollution control systems; delignification by oxygen, Deinking process, Bio-methation process (Chinnaraj,2003, TNPL,2016), On-site Precipitated Calcium Carbonate (PCC) plant, Soda reclamations, Reuse of lime sludge for brunt lime production, Segregation of process condensate and utilize it for lime mud washing in caustizer plant, up-flow anaerobic sludge blanket rector (UASBR).Optima reactor – A, B, C, High rate solids contact clarifier, Chemical recovery condensate, and Black liquor filtrate collection are used in such firms(TNPL, 2016, Nandy, Tapas, 2002, GCPC, 2010).

Chlor Alkali/ Caustic Soda:
These materials are used in Scrubber Provided in HCL plant and Ethyl Silicate Plant. , Absorption towers and Polishing towers in Chlorine, liquification Plant, Scrubber in TCE plant-Caustic fusion plant, salt heater, Nano feed tank, and Nano permeate tanks (GCPC, 2010).

Iron and Steel:
Recycling of spent pickle liquor; recovery of iron scrap and implementation of close-looped systems. (Co-processing notification, (CPCB, 2010) BF–BOF: The blast furnace and basic oxygen furnace route.2. DRI–EAF: Coal or gas based direct reduced iron (sponge iron) and electric arc furnace route.3. COREX–BOF: The Corex process followed by basic oxygen furnace for conversion of iron into steel, 4. Induction Furnace (energy saving technology) (Ministry of steel, 2017). The induction furnace route for melting and production of steel. Slag Granulation Plant: Filter Beds Settling Tank., Pig casting Machine Section (Semma unnaikrishnan et.al., 2000, SAIL,2013,Sengupta, 2013, CPCB, 2008) **.**

Chemical industry:
Cleaner Technology can be considered a strategic element in the manufacturing technology for present and future products in the chemical industries. These industries are characterized by certain processes such as membrane electrolysis for fine chemical intermediate synthesis, processes using enzymes, fermentation route for biodegradable plastic production, transportable formulation plant for industrial explosives, aqua base paint system, hydrogen peroxide for cleaner oxidation, clean alternatives to chlorinated and aromatic solvents, pressure swing adsorption to recycle hydrocarbons, production of single isomer using chiral technology, increased charging density, repair of leaks, minimization of chemicals use, proper, material inspection and handling, non-calcium chromite roasting, absorption heat pump and inert-gas stripping (GCPC-ENVIS, 2010).

Sugar industry: Co-generation using Bio-mass/Bagasse/Biogas, Lime recycling, Co-processing soda recovery, Condensate polishing unit (CPU), Variable frequency drive (VFD), Up-flow anaerobic system (USAB), Up-flow Sludge Blanket (USB), and composting(press mud) has a organic fertilizer Flow meter are frequently used (Pooni sugar, SISMA, 2016, GCPC-ENVIS,2010).

Dye and Pigment manufacturing:
Sulfuric acid, Oleum, Sodium bisulfate, Gypsum recovery, Spend sulfuric acid concentration and reuse, Recovery of salts such as sodium sulphite, sodium Effective washing of Gypsum sludge and use in cement manufacture, Recovery of Mercury naphthalene from their sludge. Manufacture of pigment from iron sludge, Regeneration of spent carbon, Incineration of organic residue, Secured land filling of Ash, ETP sludge, Removal of color by Adsorption/Oxidation /Bleaching, Flash Dryer, Spray Dryer, Solar Dryer as a Technology up gradation use of sun drying. avoid the manufacture of azo dyes and provide alternative dyestuff to users such as textile manufacturer smelter & control the quantities of toxic ingredients to minimize wastage reuse byproducts from the process as raw materials or as raw material substitutes in other processes• use automated filling to minimize spillage, use equipment. Wash down waters as make-up solutions for subsequent. Batches, return toxic materials packaging to supplier for reuse, where feasible, find productive uses for off-specification products to avoid disposal problems, use high pressure hoses for equipment cleaning to reduce generation of waste water, label & store toxic & hazardous materials in secure bunded areas, Pigment Blue Plant Reactors (acid fumes)(CPCB, 2003, GCPC-ENVIS,2010).

Pesticide Formulation Industry:
In this sector, the substances involved in production are extremely diverse. Many are flammable and toxic and waste is produced at each step of the product synthesis. Substitution of isopropyl acetates for toluene and implementation of recovery schemes; replacement of two-solvent extraction system with a single environmentally more benign solvent are some of the technologies used (CPCB, 2006, GCPC-ENVIS, 2010).

Tannery industry:
The major processes involved in this sector are vegetable tanning, hide chilling to avoid salt in the effluent hair recovery processes to reduce (BOD/COD) of the effluent, enzyme-assisted unhearing to reduce supplied CO_2 de-liming to reduce ammonia in the effluent, better uptake/exhaustion of chrome or chrome recovery/recycling to reduce chrome in the effluent, alternative mineral tanning agents to avoid chrome in the effluent or solid wastes, water-based and solvent-free top coats to avoid VOC emissions (EPA,1989),powdered activated carbon and membrane bioreactors (MBRPAC), membrane bioreactor (MBR), electro chemical treatment, advanced oxidation **processes** for water, membrane process, used/spent oil –Chromium bearing residue, and sludge chemical sludge from waste water treatment (CLRI, 2002, 2010, NEERI, 2003, 2006, GCPC-ENVIS,2010).

Distillery:
Bio-earth composting, Potash recovery, Bio-gas process using USAB, Bio- methanation Azeotropes Distillation, Molecular Sieve Technology, Energy**-**Cogeneration plant using Biomass/Bagasse, Variable frequency drive (VFD), RO, UF, MF, Bio Digester (Sarayu et al., 2019), Bio Gas Holder Bio Gas Blower, .Incinerator boiler, Surface condenser, Vapor liquid separator, Spent wash feed tank, and Spent wash feed pump Centrifugal type are common technologies used in such firms (Indian distillers association, 2018, SISMA,2016, Sakthi sugar annual report,2015, Ponni sugar,2016, GCPC, 2015) .

Copper smelter
Process gas streams containing sulfur dioxide, Energy efficiency measures and Storm waters should be treated for suspended solids and heavy metals reduction (GCPC, 2015).

Fertilizer:
Use synthesis NH_3 purge gas treatment to recover NH_3 and H_2 before combustion of the remainder in the primary reformer Installation of prilling towers with natural draft cooling, recycling of urea, Install steam droplet separation techniques (e.g., knitted wire, mesh demister pads, wave plate separators and fiber plate (Seema unnikrishan 2000, GCPC, 2016)**.**

Thermal power plant
Ultra-Super Critical (USC) coal-based power plant has an efficiency of 46 per cent compared with 34 per cent for a sub critical plant and 40 per cent for a Super Critical (SC) plant. Thus, with an USC or SC plant, the savings in coal consumption and reduction in CO_2 emission can be substantial. A 10,000 MW power plan in National Clean Energy Fund (NCEF).Clean coal technology as Bucket Wheel Excavators (BWE), Mobile Transfer Conveyors (MTC), Conveyor system, Tripper and Spreader etc. Implementation of Variable Voltage & Variable Frequency (VVVF) Drives, PLC Based Automation System for Lignite Bunker, Storm Water Management, integrated Gas Combined Cycle (IGCC) (NLC, 2013).

Technical assistance
Trade in environmental services and technologies (TEST) with the help of a U.S based technical coordinator for promoting business ventures between India and other countries were identified. They include appropriate technology on technical, efficient in reusing, recycling and by-product TEST programme with (ICICI) projects, loan to control pollution and energy conservation schemes and equipment finance. Under cleaner technology finance, ICICI offers assistance under programme for advancement of commercial technology (PACT). The programme for acceleration of commercial energy research (PACER), the programme for acceleration of commercial energy research (PACER), Agricultural commercialization and enterprise programme (ACE) and sponsored research and development programme (SPREAD) and trade in environmental services and technologies (TEST) are providing assistance for upgrading technology to promote CT and also waste minimization circle (PRISMA) studies in the Netherlands to assist the small and medium industrial estates, Asian productivity organization (APO) and Commission of the European communities (CEC) (Prasad, OECD,1995) (PRISMA) (Project industrial successes with waste prevention). Studies in the Netherlands assist the small and medium industrial estates, and chemical manufacturer association (Jos Frijns, 1997) EnviroLink Network, U.S Environment Protection Agency (EPA) - Environmental Technology Opportunities Portal (ETOP) Commonwealth Scientific & Industrial Research

Organization (CSIRO), Council for Scientific and Industrial Research, Ghana (NEERI, 2019) .

Research and Development

The European Union-India Joint Environmental Education Program (EU-In-JEEP) was undertaken to promote interaction by between India & European countries in the field of Preventive Environmental Management (PEM). The networks of educational institutes involved in this project include two European institutes. The International Institute of Industrial Environmental Economics (IIIEE) at Lund University, Lund, Sweden and the Centre for Regional Development (CRD) at the University of Twenty, Netherlands and Indian Institutes Indian Institute of Technology, Bombay (IIT-B), and India and Environmental Protection Training & Research Institute (EPTRI), Hyderabad, India. This Program is funded by the commission of European Communities and is coordinated by the international institute for industrial environment economics (IIIEE) at Lund University (Hedge et.al. 2000). The main objectives of this program is to include education on preventive environmental management (PEM) related issues, establishing study centers in India for educating students and representatives from industries and developing tools for implementation i.e. data base, newsletters, manuals etc. and establishing a 28 continuous transfer of knowledge between India and European countries in the field of PEM (Shyam, 2005, Hedge et al., 2001). National environmental engineering research institute (NEERI), Central leather research institute (CLRI) National air quality monitoring programme (NAMP) (National productivity council (NPC), Central building research institute (CBRI) are research institutions. The initiatives by central government, CPCB, SCPB, GCPC have enrolled students of national institutes such as IIT-Kharagpur and IIT- Rourke (GCPC, 2014)

Data base management system (DBMS) and portal of cleaner production

The GCPC portal was initiated in 2003 to tie up with environmental management system ENVIS which is portal by MoEFCC. CPCB portal also updated pollution rate, update of technology in pollution prevention. GCPC also acts as an (ENVIS) Centre on Cleaner Production /Cleaner Technology since 2005, for Ministry of Environment, Forests and Climate Change (MoEFCC), operating/maintaining/updating website, www.gcpcenvis.nic.in and also publishing a quarterly newsletter. (MoEFCC) instructed 60 numbers. Other ENVIS Centers across India, to replicate the Format of GCPC-ENVIS. (GCPC, 2014, Bharat Jain, 2014).

Clean cell division by (MoEFCC) Research and development

Clean technology cell division by (MoEFCC) has a scheme called development and promotion of clean technology and waste minimization demonstration project for development of cleaner technologies to facilitate access to clean technology and its adoption by the small and medium scale collaboration with industries/consortium for setting up pilot/demonstration projects For new technology/up-gradation of available technology/ Research and development (R&D), in such industrial clusters, 24 industrial sectors have been identified by the Ministry. At present the scheme has 18 ongoing projects, 6 new projects and 25 completed projects. Documenting and reporting of research activities for Small and medium firms (SME) (Clean division cell, 2013).

Institutional background of energy in firms

Now all the multinational national companies (MNC) are adopting CT because of the low energy utilization. Energy conservation as co-processing or co-generation technology usage of less raw material (chemical and water), recycling, reuse and reduce 3R, such as co-processing units are used in MNC (multinational national companies).Energy conservation techniques are also used in large and medium scale industries in cement industries, iron and steel, coal, fertilizer, sugar, and distillery.

Waste minimization Database of India (WMDBI)

The waste minimization database of India was developed with the support of World Bank by the Centre for environmental science and engineering (CESE) at the Indian Institute of technology (IIT) Bombay and science application International Corporation, Washington D.C., USA (NEERI, 2019).

Strengthening the regulation and compliance

Some of the activities to encourage student researchers to enhance (R&D) such pilot project, institutions like (National institute of technology (NIT), Indian Institute of Technology (IIT) are encouraging engineering students to have project seminars, conference and capacity building activities (GPCB/GEMI/GCPC). Under Environmental surveillance system (ESS) activities, highly polluting industrial units falling under 17 categories of Industries are selected through especially developed software for surprise inspection / monitoring to check the compliance of consent conditions, stipulated standards, CREP, etc. ESS inspections are conducted through six Zonal Offices of CPCB in 2017 located at Bangalore, Vadodara, Lucknow, Bhopal, Shillong and Kolkata (CPCB, 2017).

Economics of cleaner technology in controlling industrial pollution

Clean technology is given very high priority. The cost of maintenance is high comparing with End-of-pipe (EOP) technology. Basically there is a single type of technology in process to treat all the waste and the concentration of waste material differs. So CT is given Subsidy, Soft loan and deprecation, reduction in taxes related to pollution control benefit is high and depends upon the product. Additionally incentives are offered by different audits in large scale industry. State pollution control board (SPCB) is concerned with medium and small industrial units which are given incentive and more concentration and the incentives focus on small firms to encourage the use of cleaner technology. Some of the schemes are directly prioritized by the Ministry of Environment and forest (MoEFCC) and ENVIS, central government research and development center that is coordinated by the government of India Environmental Valuation and Cost-Benefit (NEERI, 2019) .

Overseas funding agency investment in India to improvised (Cleaner technology)

This project was prepared by (MoEFCC) to utilize the support of the World Bank to prevent and alleviate environmental degradation by industrial development. The project involved a credit of US$155.6 million and another fund of US$ 108 million to be provided by government of India, were state government, financial institution (IDBI and ICICI) (OECD, 1995). The main objectives of this project are the following:

1. To ensuring sub-loans to individual industrial unit's large, medium and small scale to install pollution control equipment's.
2. To provide Sub-loans and sub- grants for setting up CETPs connected ZLD for industrial clusters in an area (SMEs).
3. To establish demonstration projects on cleaner technology (training programs, strengthening institutional background and focusing on research and development. (Ministry of finance, 2016).

The project focuses on targeted sectors on cleaner technology such as focus on up-gradation of older technology, waste minimization, including resources, recovery system, inbuilt, and process Modification. The projection mainly focuses on CREP initiatives on red categories industries (CPCB, 2003) chemical, fertilizer, leather tanning, dye and dye intermediates pesticides and insecticides, pharmaceuticals, chemicals, petrochemicals, pulp and paper, sugar and distilleries.

Energy Conservation (Co-generation) and funding

In all red category industry, Capacity building for clean development mechanism (CDM) intensified in energy conservation projects. Making the policy of Perform-Achieve-Trade (PAT) is a market based mechanism under the Bureau of Energy efficiency (BEE) scheme and it covers eight guzzling sectors such as thermal, power, aluminum, cement, fertilizer, iron and steel, paper and pulp, textiles, and also cholr-alkali. These sectors account for 40 percent of India's primary energy consumption. The target is to save 6.68 million tonnes of oil (Ankur Paliwal, 2012). Ministry new and renewable Energy Sources (MNES) Grid connected to power are classified as wind power, and Bio-power that is further classified into Biomass power / bagasse cogeneration, Non-bagasse cogeneration, Biomass gasifier, Urban & Industrial wastes, Small hydro power (up to 25 MW station capacity), and Solar Thermal and Solar Photovoltaic Power. Grid-interactive renewable power projects based on wind power, biomass, and small hydro and solar are mainly private investment driven, with favorable tariff policy regimes established by State Electricity Regulatory Commissions (SERC), and almost all-renewable power capacity addition during the year has come through this route. The Off-grid Renewable Energy / Power such as**1**.Biomass based heat and power projects and industrial waste to-energy projects for meeting captive needs, 2.Biomass gasifiers for rural and industrial energy applications, and 3.Small Wind Energy & Hybrid Systems is given for mechanical and electrical applications, mainly where grid electricity is not available. The government has given soft loan, subsidy, tax benefits, workshops, pilot projects in the cooperative sector and lower customs duty for importing technologies. There are several industries such as sugar, paper and pulp, textiles, fertilizers, petroleum, petrochemicals and food processing, and they require electrical as well as thermal energy for their operations. These requirements can either be met through different energy sources. The power generated from such co-generation plants can be used for meeting the captive requirements and the surplus power produced can be exported to the state electricity grid. The funding scheme at present has project, technical up-gradation, and training facilities for small, medium and large scale industries (Ministry for new and renewable energy resources,2017). US Agency for International Development (USAID) has contributed up to 10 percent equity for nine demonstration projects, trainings, workshops, newsletters and outreach activities. The Indian Renewable Energy Development Agency (IREDA) offers multilateral lines of credit for renewable energy development obtained from international and bilateral finance institutions. The Asian Development Bank (ADB) provided funds dedicated for The total installed capacity for sugar based cogeneration in India is around 3500 MW, this has a gross potential to generate about 5000 MW Raghu, 2003 of such power annually, as per (MNRE report Central Electricity Regulatory Commission,2012).bagasse/biomass/cogeneration to Clean Development Mechanism (CDM) Project-based carbon off-setting programme established under the Kyoto Protocol. 79 Projects Registered Under clean development mechanism in India (CDM-Registry, 2015).US$19 million effort is funded through the United States' contribution to the pilot phase Global Environmental Facility (GEF)The United States Agency for International Development (USAID), Greenhouse Gas Pollution Prevention (GEP), Project Bureau of Energy efficiency (BEE), State Electricity Regulatory Commissions (SERC), Asian Development Bank (ADB) (Scott et al., 1998).Project which is under preparation to provide creative financing to cooperative mills. India has set targets to achieve an installed cumulative, grid connected renewable energy capacity of 74 GW by 2022 (15 percent of total energy) which is 4.1 percent at present (MNRE, 2018). To keep an account on energy industry Certified Emission Reductions (CER) (Smita Sirohi, 2009) using a systematic approach to compare the energy conservation year by year, energy audit is done Energy management system (EnMS) Certification is given by ISO-50001 (CSO, 2013).

Discussion

1. Energy is an issue after water air and solid waste system cleaner technology gives more focus in process change, add-on, and co-processing (off-grid renewable) cogeneration technology.
2. In 17 industries (Ultra-red categories industry) only textiles is not in ultra-industry but this industry has a huge amount of water and solid waste using advanced technology zero liquid discharge (ZLD).
3. Nuclear power industry has no clear review on adopting cleaner technology and CPCB has not given any notification of technological up gradations.
4. Water polluted industry uses advanced technology like zero liquid discharge (ZLD).

5. Air pollution control still in industries are using the older technology like ESP, Wet and dry Scrubber but now a days advanced technology like plasma technology (Thermal and non-thermal) (Penetrante et al., 1993) to control air pollution by adsorption and absorption technology is used in process on cost the maintenance is high compare to old technology but its efficiency is high not financially viable unless all economic, social and environmental costs and benefits for all parties affected by the project are included. Compared to alternative flue gas treatment technologies (Andra et al., 2015).

Recommendation

On this study it has been discussed the central pollution control board, state pollution control board, Ministry of forest and environmental climatic change contribution in promoting and up-gradating notification of cleaner technology still there is the gap in research and development, strengthening the regulation policy in cleaner technology. Where every large-scale industry are multinational company (MNC) they have a direct policy from the EPA and well in CPCB from CPCB and SPCB have to send ESR (Environmental statement report) and pre and post EIA, training on pollution, reports all are mandatory and CPCB has set online monitoring system for air, water and hazardous waste. But on the other side they have an (internal and external) audit system like quality management system, Environmental management system and Energy management system it's done by private consultation the negative role is time delay, lack of transparency and the cost for auditing (CPCB-ENVIS, 2001) is too high all the cleaner technology are recorded and reported in this has a third-party consultant this has to be mandatory done by CPCB and SPCB, India has to promote in a higher diffusion of self-reliance in product manufacturing (intellectual property rights) improve in research and development.

Conclusion

CPCB,SPCB,TNSPCB has to take in control of cleaner technology and advancing the research and development to have an insight research technically in high motto and regulation policy has to be strict in nature has giving third-party like audit to environmental management system consultant should give a detail report on the industrial audit to pollution control board committee it has to made mandatory.

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