Community Steam Boiler - A shared energy source for Eco Industrial Park in Gujarat

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Abstract:

Generally, number of small boilers operating in the MSME industries in any industrial sector of the region is significant. These boilers are mainly used for generating steam which is generally used in process or for heating purposes. They consume massive quantities of fossil fuels (majorly coal). Emissions standards applicable to such boilers are quite lenient. In most cases, installation of air pollution control devices is either not applicable, or they are insufficient to control emissions. Also, these boilers follow a batch operating process—each batch of fuel is consumed in about 30–40 minutes and then fuel feeding is required. One small boiler can be monitored for actual emissions only for about 30–40 minutes in an hour or may be even less than that. Moreover, fuel feeding is mostly done manually. Therefore, installation of any type of Continuous Emissions Monitoring Systems (CEMS) will not be fruitful as the boilers are in standby mode for a sizable amount of time during a day.

In this paper, a common steam generation and distribution facility in industrial estate is discussed. Such systems are sometimes termed as common boilers or community boilers and can cater to the steam requirement of a specific number of industrial units. If feasible, such technology could free the regulatory bodies of the hassle of monitoring a large number of small boilers in certain industrial areas and reduce the environmental load of individual industries.

Keywords: Community Boiler, shared energy, Eco Industrial Park, Community heating, Steam

Introduction:

The fundamental idea of District Heating is 'to use local fuel or heat resources that would otherwise be wasted, in order to satisfy local customer demands for heating, by using a heat distribution network of pipes as a local market place'. District heating was first commercially introduced in cities as Lockport and New York in the 1870s and 1880s. However, a medieval pioneer system existed already in Chaude-Aigues, France in 1334, by distributing hot water from a geothermal source to some buildings in the village. The first European commercial systems were introduced in Germany in the 1920s. The planned economies of Soviet Union and China introduced district heating in the 1930s and 1950s, respectively.

Nowadays, major district heating systems appear in cities as Moscow, St. Petersburg, Beijing, New York, Kiev, Seoul, Warsaw, Berlin, Hamburg, Helsinki, Stockholm, Copenhagen, Paris, Prague, Sofia, Bucharest, Vienna, and Milan. The total number of systems has been estimated to 80 000 systems, thereof about 6000 systems in Europe.

The main user categories of district heating are industries and buildings. During 2014, these customers bought 11.5 EJ of heat from district heating activities in the energy sector according to the IEA energy balances. Russia, China, and the European Union were responsible for 85% of these heat deliveries. The user category proportions were 51% to buildings, 45% to industries, and 4% to others.

All districts heating supply in China is reported as coming from boilers, although the real proportion of heat supply from CHP plants was 40 % in average between 1990 and 2014. Steam was the heat carrier in the first generation, while water has been the heat carrier in the following generations. Carbon dioxide as future alternative energy carrier has been advocated. Most first generation systems have been converted to water systems or been closed, since steam is nowadays considered an inefficient heat carrier with respect to heat losses and maintenance costs. However, steam is still used as heat carrier in the Manhattan system in New York and in the central system in Paris.

Industrial heat demands are connected to the networks in a similar manner. If the industrial customer is located close to the local heat supply plant, a special pipeline connection can provide another temperature level required. Best available technology in Europe has been to use heat meters for measuring the heat delivery for each customer. They are now providing automatic readings and the measurements are transferred to the heat provider with wires or wire-less methods in order to generate invoices.[1]

Steam requirement of Industries in Gujarat:

Gujarat is India's most industrialized and urbanized state. Gujarat has established itself as a manufacturing powerhouse for sectors such as auto & auto components, chemicals & petrochemicals, drugs & pharmaceuticals, cement, textiles, engineering, gems & jewelry and ceramics. MSMEs form an integral part of the entire supply chain of these large companies in the state. They act as ancillary units to large industries contributing significantly to the industrial development of the state. There are over 100 MSMEs multiproduct activity clusters spread across the state[2].

Steam systems are a part of almost every major industrial process today. Major percentage of the fossil fuel burned to produce steam. This steam, intern, is used to heat processes, to concentrate and distill liquids, or is used directly as a feedstock. All of the major industrial energy users devote significant proportions of their fossil fuel consumption to steam production for example: food processing (57%), pulp and paper (81%), chemicals (42%), petroleum refining (23%), and primary metals (10%). Since industrial systems are very diverse, but often have major steam systems in common, it makes a useful target for energy efficiency measures[3].

Presently most of Industries like Textiles, Paper Mills, Rice Mills, Palm Oil Processing, Chemicals, Pharmaceuticals, and Pesticides etc that need steam for their production generate steam by individual small boilers from sizes ranging from 100 kgs/hour to 30 TPH in Gujarat[4].

Issues with small boilers at Individual Industries

• Emissions standards are lenient: The emissions standards for small boilers are quite relaxed. For boilers with capacity of less than 2 TPH, the PM emissions norm limit is 1,200 mg/Nm3. Thus, even if these boilers are meeting applicable standards, pollution load from them will be high.
• Number is large, difficult to be physically monitored by SPCBs: About 50 per cent boilers installed in the seven study areas in the Delhi-NCR air shed are small boilers. It is difficult to follow the mandate of monitoring these boilers periodically with the limited capacity of regional SPCBs.
• Air pollution devices have not been installed: Proper air pollution control devices have not been installed in most of the industrial units. Even when installed, they are not working satisfactorily.

• Usually operate through batch-type process: Frequent restarts result in poor operational efficiency and inaccurate monitoring results through CEMS. • Manual coal feeding and no automation.
• Safety: Several cases of boiler explosions are recorded every year, including causalities (mostly of manpower involved in boiler operation and other skilled or unskilled labour). Installation of big boilers with professional management will save lives and prevent injuries[6]

Community Boiler installed in Gujarat:

Looking to the success stories of district heating system in different countries, the concept of "Community Boiler" to supply the steam to the individual industries in the Industrial Estate emerged in Gujarat in the year 2015 by Steam house, Steam House, a venture of the Sanjoo Group, is a first-of-its-kind company in India that focuses on leveraging IoT to provide Steam-as-a-Utility to industries through a grid of pipelines[5].

A common boiler with efficient Air Pollution Control Mechanism and robust steam distribution network to provide steam in place of individual boiler in each industry is an alternative for Industrial Estate for better Environmental Compliance and economical benefits to member industries[4].

For such systems, either atmospheric fluidized bed combustion (AFBC) boilers or circulating fluidized bed combustion boilers (CFBC) are preferred. In an AFBC boiler, the furnace pressure is atmospheric pressure whereas in a CFBC boiler, to increase the thermal efficiency of the boiler, the furnace is pressurized and furnace gas is recirculated to capture unburnt carbon. Thermal efficiency of a common FBC boiler is in the range of 80–85 per cent. Since proper air pollution control devices (APCDs) are available for such systems, PM emissions levels can be reduced to as much as 30–50 mg/Nm3. Low furnace temperature inside a CFBC boiler suppresses NOx formation. SO2 emissions can be controlled by auto-injection of lime and selection of the right fuel. The availability of steam at the doorsteps of units operating in an industrial estate is one of the major advantages of common boiler systems. It lets industrial units focus manpower, space and money on their core production activity[6]

The first community boiler commissioned at Surat in Sachin GIDC Industrial Estate in the year 2015. At present there are more places like Vapi, Ankleshar, Sarigam, Nandesari, Panoli where community boiler has been installed between year 2017 to 2021.

Benefits of Community Boiler:

There are several benefits of switching over to common boiler-based steam generation from small boilers installed in the premises of industrial units:

1. No hassle (and cost) of operation and maintenance as no boilers installed: No downtime and improved availability of steam. Shutdowns are minimized as common boilers of larger capacity do not require frequent maintenance.
2. Reduction in industrial air pollution by 65–70 per cent, with better emissions control and a 25-30 per cent reduction in coal consumption.
3. One point monitoring for SPCBs. The liability to install CEMS not applicable to small industrial units as the common boiler functions independent of them.

4. Increasing productivity as requirements to procure fuel, set aside manpower for operation of the boiler, and coordination between demand and supply of steam no longer required on the part of the small industrial unit.
5. Increased efficiency: Fuel-to-energy conversion improves as producing steam in bulk reduces the per unit fuel consumption.
6. Safer industrial areas: Removal of boilers from small industrial operations makes them safer.
7. Auto-firing and automatic ash handling: Providing hygienic conditions to workers.
8. No fuel storage area required: Thus saving space for small industrial units. 9. Ease of doing business for industrial units.[6]

As per the feasibility study of Centre for Science and Environment in Replacement of Small Boilers with Common Steam Boilers in Industrial Areas in 2020, A common boiler facility scores over a boiler with a capacity of 2 TPH on key economic, technical, regulatory and environmental aspects where Comparative cost–benefit analysis of a small boiler and a common boiler are given as below.

Type of benefit	**Parameter**	**Unit**	**Industrial units with a small boiler (2 TPH)**	**Industrial units with a common boiler**	**Remark**
	Capacity	**TPH**	**20**	**No boiler installation**	
Economic	Boiler cost	Rs	7,00,000	0	Cost of installation of one small boiler of 2 TPH saved
Economic	Operation and maintenance (O&M) cost	Rs per year	1,00,000	0	Assumed cost of O&M is Rs 1,00,000 for one small boiler
Economic	Cost of APCD	Rs	5,50,000	0	An APCD is often not installed on a small boiler; cost of a wet scrubber has been considered
Economic	Productivity		Less	More	More productivity means more profit
Technical	Automation		Nil	Not required, as no boiler present	Manual feeding in case of a small boiler, no automated control, more labour requirement, and an unhealthy working environment
Technical	Efficiency	Per cent	65–70	80–85	Increased efficiency
Technical	Steam availability		Intermittent	Continuous	
Environmental	Emission standards for PM	mg/Nm3	1,200	No norms to be followed (as boiler not	Reduction in air pollution by 65–70 per cent as PM norm limit for common boilers is

				installed onsite)	generally 150 mg/ Nm3
Environmental	Monitoring cost	Rs per year	1,20,000	No monitoring required	Considering stack monitoring cost to be Rs 10,000 per monitoring per month
Environmental and economic	CEMS cost	Rs	10,00,000	No CEMS installation required	
Regulatory	Regulatory inspection	Number of visits per year	4	May visit for other inspections	Four inspection visits per year (quarterly) by SPCB officials for each industrial unit. Once the industry switches over to the common boiler system, no inspection is required related to air pollution control
Regulatory	Boiler		permission Required	Not required	

Table: Comparative cost–benefit analysis of a a common boiler, CSE 2020[6]

Financial Incentive for Community Boiler from Government of Gujarat:

To encourage the industries association of various government and private industrial estates to install community boiler, Government of Gujarat has added financial incentive for installation of community boiler in Scheme for Assistance for Environmental Infrastructure under Industrial Policy 2020.

Common Boiler Project by SPV constituted by Minimum 10 MSME's:

Eligibility Criteria:

1. Project should be promoted by SPV of minimum 10 MSME using steam in the process and having independent Boiler in their premise.
2. New Boiler should be Energy Efficient i.e. it should be using less fuel to provide the same level of energy as certified by Office of the Boiler Inspector.
3. All statutory permissions from concerned authority for operation of Boiler and Distribution pipe line shall have to be obtained by SPV.

Quantum of Assistance:

- 35 % or maximum Rs. 2 Crore, if solid fuel used and 50 % of cost maximum Rs. 2 Crore., if cleaner fuel like CNG, PNG, Bio Fuel etc is used for Common Boiler Project.[7]

Conclusions:

The average share of small boilers in the overall pollution load in industrial areas is in the range of 6–16 per cent. However, this number may be much higher in industrial areas with a significant number of small boilers. In such areas, common boiler systems may be considered. Estimates suggest that the cost of producing steam in small boilers with inconsistent usage of coal is around Rs 3/kg. The cost of producing steam in coal-fired boilers of less than 2 TPH capacity is Rs 2/kg. If an industry switches over to a common boiler service, the cost will be in the range of Rs 1.8–2.2/kg, but the overall CAPEX and OPEX will decrease significantly. In addition, there are advantages related to environment and increased productivity. Moreover, about 30 per cent of the steam cost is fixed cost whereas 70 per cent is fuel cost and tends to vary. The latter will be stabilized and reduced in common boiler facilities. Common boilers should be included in the developmental plan of an industrial area at the planning stage itself as a basic necessity, and sufficient land should be allocated for such facilities in the initial development stage of the area.

References:

1. Sven Werner, International review of district heating and cooling, Energy, Volume 137, 15 October 2017, Pages 617-631, https://doi.org/10.1016/j.energy.2017.04.045, 2017
2. Industries Commissionerate, Government of Gujarat, https://ic.gujarat.gov.in/documents/commondoc/2020/Industrial-Policy2020.pdf (2020)
3. Dan Einstein, Ernst Worrell, Marta Khrushch, Steam Systems in Industry:Energy Use and Energy Efficiency Improvement Potentials, https://escholarship.org/uc/item/3m1781f1, 2001
4. Steam House, https://cdn.cseindia.org/attachments/0.57183400_1595829045_steamhouse.pdf (2020)
5. https://www.steamhouse.in/
6. Shobhit Srivastava, REPLACEMENT OF SMALL BOILERS WITH COMMON STEAM BOILERS IN INDUSTRIAL AREAS, Centre for Science and Environment, file:///C:/Users/Admin/Downloads/http___cdn.cseindia.org_attachments_0.35824400_1594990537_replacement-of-small-boilers-with-common-steam-boilers-in-industrial-areas.pdf, 2020
7. Industries Commissionerate, Government of Gujarat, https://ic.gujarat.gov.in/documents/commondoc/2020/12-GR_02092020.pdf, 2020
8. Anon 1986. 'Section 70: Boilers (Small)', The Environment Protection Rules 1986, New Delhi. Available at https://cpcb.nic.in/displaypdf.php?id=SW 5kdXN0cnktU3BlY2lmaWMtU3RhbmRhcmRzL0VmZmx1ZW50 LzQ1OS0xLnBkZg, as accessed on 20 June 2020 2.
9. Anon 2018. The Gazette of India, New Delhi. Available at https://cpcb.nic.in/ uploads/Industry-Specific-Standards/Effluent/106-industrial_boiler.pdf, as accessed on 20 June 2020 3.
10. Anon 1986. Boilers using agricultural waste as fuel, New Delhi. Available at https://cpcb.nic.in/dis playpdf.php?id=SW5kdXN0cnktU3BlY2lmaWMtU3 RhbmRhcmRzL0VmZmx1ZW50 LzUxNC5wZGY, as accessed on 20 June 2020