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Solar Industrial Process Heating system for Indian Automobile Industry

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ABSTRACT

Indian automobile industry is one of the largest in the world. To match production with demand, many automobile makers have started to invest heavily in various parts in the industry. Automobile industries have number of different production that needs large amounts of energy in form of electricity or heat. In automobile industry over 65% of the energy demand is for heating. Possible integration with proper solar thermal technology depending on the temperature range achieved by different solar collectors and temperature needed for process provided by heat application media. It also shows the current energy source or fuel being used to achieve these processes. Proposed system combines the direct steam generation concentrating collectors with the fossil fuel fired high pressure boiler. Solar thermal technology can be installed in the most automobile industrial sectors to lower consumption of fossil fuels, cut production costs, preserve environment by lessening CO2 emissions. Concentrating solar collector field is mounted on the roof of an industrial production site to Solaris the supply of saturated steam into steam network.

Keywords: *Automobile Industries; Heat Energy; Solar Thermal Technology.*

1.0Introduction

Demand of heat energy accounts for around 70% of total energy consumption in any industry, therefore solar heat for industry can be perfect application of solar thermal technology as solar collectors can provide most of this heat energy demand. Also the India has a great potential for solar industrial heat because of high solar irradiation for almost 300+ sunny days in year. Apart from these reasons, Shortage of fossil energy sources such as oil, gas or coal with rapidly rising energy consumption in developing countries like India have result in hike in energy prices. From now integration of solar thermal technology with industrial heat sources will increase India's independence from future energy price hikes and help to lessen industrial production costs. Now a day, the automobile industry is under great strain to make their products more environmentally sound in this 21st century especially after C02 emission laws made in Kyoto protocol. Not only the automobiles themselves, but the whole production has to become more sustainable. Therefore there is urgent need for more sustainable automobile production with lessened demand for energy, materials and as well as emissions.

2.0 Performance of Indian Automobile Industry in 2014-15

The Indian automobile industry is one of the largest in the world with an annual production of 2,33,66,246 automobiles including passenger vehicles, commercial vehicles, three wheelers and two wheelers in fiscal year 2014-15 as compared to 2,15,00,165 vehicles produced inyear 2013-14 with a annual growth of 8.68 % . [1] The automobile industry has a very high share in the country's manufacturing gross domestic product (Gross Domestic Product). India is also a major automobile exporter, with huge export growth expectations in the near future. Sales of passenger automobiles in India grew by 3.90 percent 2014-15 from a previous year ago, according to data given by Society of Indian Automobile Manufacturers (Society of Indian Automobile Manufacturers). Sales of cars also grew at 4.99 % in 2014-15 over the last period. Figure 1 [2] shows the production

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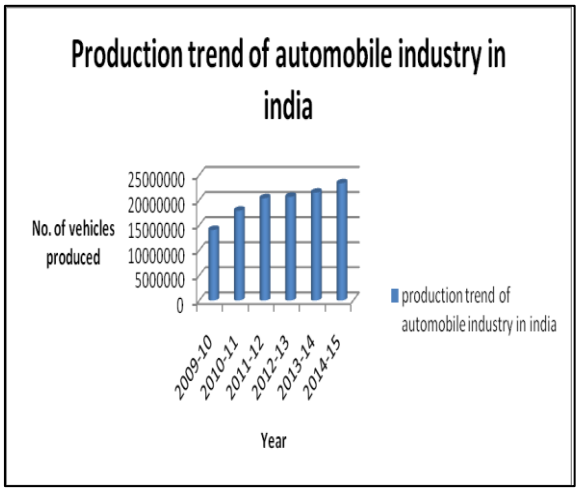
trend of automobile industry in India for year 2009-2010 to 2014-15.

Fig 1: Production Trend of Automobile Industry in India



To match production with demand, many automobile makers have started to invest heavily in various parts in the industry in the last few months. The industry has attracted foreign direct investment worth United States $ 12,232.06 million during the period April 2000 to February 2015, according to the data released by Department of Industrial Policy and Promotion. Also The Government of India encourages foreign investment in the automobile and allows 100 percent Foreign Direct Investment under the automatic route. From now the vision of government of India is to make India as the top destination in the world for make of automobiles and auto parts.

3.0 Energy Demand in Automobile industry

The Automobile industry has a very high energy demand. According to a study over 65% of the energy demand is for heating. The three major production shops in automobile manufacturing are:-

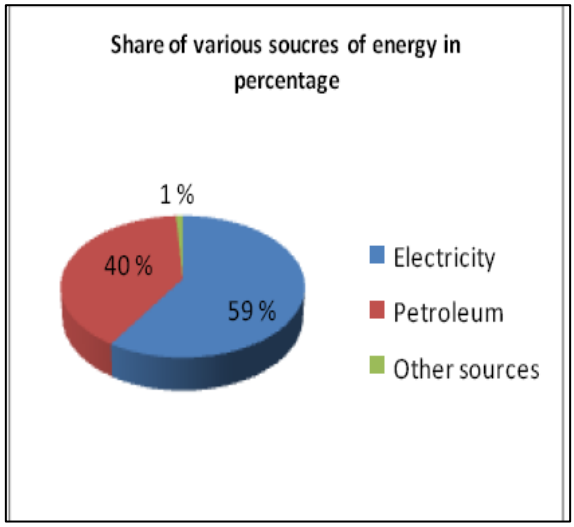
(i) Paint shop
(ii) Body shop
(iii) Assembly shop

Most automobile factories have a central steam system for producing steam at around 180°C – 200°C which supplies all processes.

Automobile industries have number of different production that needs large amounts of energy in form of electricity or heat. Various energy sources used in Automobile for different production are mainly electricity with major share, followed by petroleum products like natural gas as second largest source and followed by others sources also.

[3] Figure 2 shows to divide various energy sources used in automobile industry.

Fig 2: Composition of Energy Sources Used in Automobile Industry



Total energy consumed in automobile industry for automobile production divided in three Areas named Body shop, Paint shop and Assembly shop where different production takes place in a well-defined sequence leading to product.

Figure 3 shows to divide total energy consumption in an automobile production in various shops like Paint shop, Assembly shop and Body shop.

The following analysis can made from figure 3 on pattern of energy consumption in automobile industry that 73 % of total energy consumed in Paint shop, followed by 17% consumption in paint shop and 10%in Assembly shop.

[4] Two major sources of total energy consumption are an Electricity and petroleum product that is natural gas in automobile.

Electricity is consumed mainly in Paint shop with 45%share, followed by 35% share in body shop and rest 20% in assembly shop as shown in figure 4. Other source of energy is

Natural gas which consumed in Paint shop with High share of 92 %, small shares of 4% in Body shop and 4% in Assemble shop as shown in figure 5.

Fig 3: Pattern of Energy Consumption in Different Shops in Automobile Industry 731017total Energy Consumed in Different MaunfacturingShopspaintShopassemblyShopbody Shop

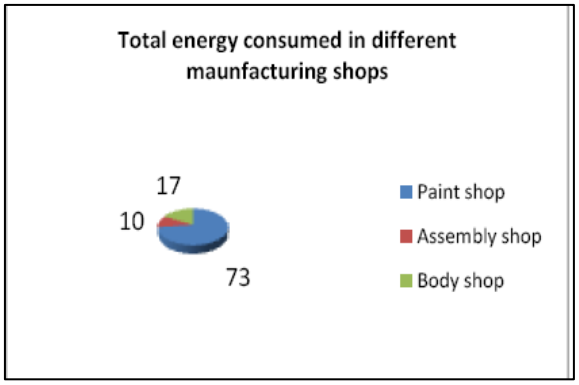


Fig 4: Pattern of Electricity Consumption in Different Shops in Automobile Industry 452035Share of Electricity Consumption In Various Shops Paint ShopassemblyShopbody Shop

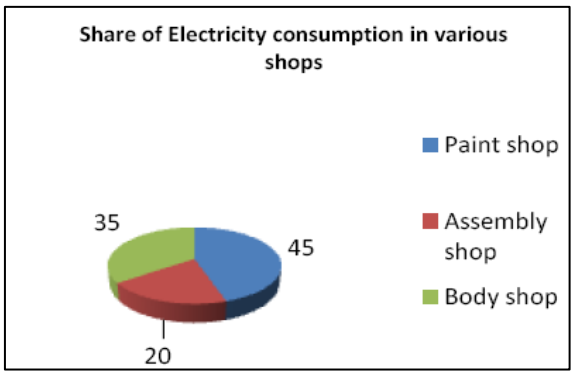
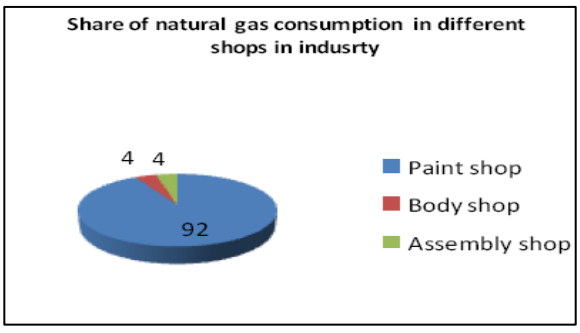


Fig 5: Pattern of Petroleum Products (Natural Gas) Consumption in Different Shops in Automobile Industry 9244 Share of Natural Gas Consumption in Different Shops in IndusrtypaintShopbodyShopassembly Shop



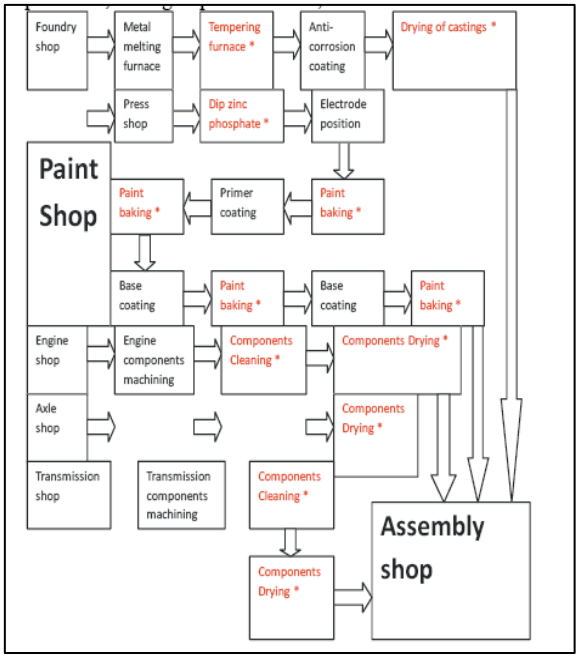
4.0 Production Processes Requiring Thermal Energy In Automobile Industry

Manufacturing automobile includes many that need thermal energy either in the low temperature range (60 – 100°C) or medium temperature range (100 – 200°C).

These are suitable for integration with solar thermal Technologies to provide industrial heat Figure 6 shows the entire flow diagram for an Automobile manufacturing. Processes marked with * need thermal energy at temperature range. Body shop includes process needing thermal energy like Drying of castings and parts, part cleaning, etc. Paint shop includes processes like Dip Zinc phosphate or 7 tank processes, baking of paint in ovens, etc.

Paint Shop Foundry shop Metal melting furnace Tempering furnace * Anti-corrosion coating Drying of castings * Assembly shop Dip zinc phosphate * Press shop Electrode position Paint baking * Primer coating Paint baking * Base coating Paint baking * Base coating Paint baking * Engine shop Engine components machining Components Cleaning * Components Drying * Axle shop Components Drying * Transmission shop Transmission components machining Components Cleaning * Components Drying *

Fig 6: Different Processes Needing Thermal Energy Marked in Automobile Industry



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5.0 Solar Thermal technology Applications in Automobile industry

Some of the typical processes in the automobile manufacturing industry needing thermal energy as shown in figure 4 now explain below in some details with temperatures needed in process and application media used like Hot water, hot air or pressured steam. [5] Figure 7 shows the temperature associated with different thermal processes in automobile manufacturing on a temperature scale.

5.1 Part Cleaning, washing or degreasing

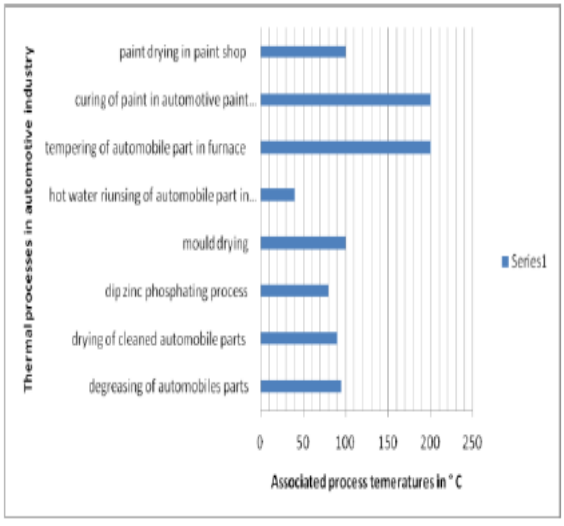
Pressured Hot water at a temperature of about 90°C sprays over the automobile engine parts to remove the dust content.

The hot water needed for spraying is heated either by electrical heaters or natural gas based heating sources.

5.2 Drying of washed parts after degreasing

The cleaned parts from Degreasing are dried in the hot air chamber in which the hot air is blown at 90°C. The hot air used is heated by using electrical coil heaters or natural gas based burners. The heating cycle depends on the size of the part to be dried.

Fig 7: Thermal Processes In Automotive Industry With Associated Process Temperatures



5.3 Mould drying

The casted or moulded automobile parts are coated with anticorrosion coatings for improving life and overall performance. These parts are then dried by hot air blown by hot air blower at high temperature of 100°C.

5.4 Paint curing process in baking ovens

After each coat of paint on automobile, the paint is baked in baking oven using hot air heated either by electrical coils or gas burners. The temperatures needed in baking ovens range around 200 °C.

5.5 Dip zinc Phosphating or 7 tank process

A standard 7 tanks or DIP ZINC PHOSPHATING process is used to achieve good paint adhesion and corrosion resistance on automobile body before painting is done.

All heated tanks are heated directly by electrical immersion hot water heaters or closed steam coils. Table 1 shows the 7 processes involved in the 7 tank process with the Temperature involved and Dip time needed.

Table 1: Steps Involved in 7 Tank Process With Temperature and Dip Time Needed

Step	Temperature in °C	Dip time in seconds
Degrease	95	15
Cold water rinse	25	5
Derust	70	10
Cold water rinse	25	5
Zinc phosphate dip	80	5
Cold water rinse	25	5
Passivation	70	10

5.6 Tempering of parts in a furnace

Hardening and tempering are normally done to improve the wear resistance, strength and toughness of the automobile parts.

Some typical application of tempering in automobile industry are low temperature tempering (150°C-200°C) of steel bearing, medium temperature tempering (350°C-550°C) of carbon steel and high temperature tempering (550°C-650°C) of medium carbon alloy steel.

Table 2 Shows the Process With Possible Integration With Proper Solar Thermal Technology Depending on thetemperature range achieved by different solar collectors and temperature needed for process provided by heat application media.

It also shows the current energy source or fuel being used to achieve these processes.

Table 2: Applications of Solar Thermal Technology in Different Automobile Production Process

Process steps	Energy or fuel being used	Application media	Temperature need °C	Recommended solar technology
Degreasing of automobile parts or part cleaning	Natural gas	Pressured Hot water	90	Evacuated tube collectors
Drying of cleaned parts	Natural gas	Hot air	90	Parabolic trough collectors with air as working medium
Dip zinc phosphating process	Electricity	Hot water	80	Flat plate collector
Mould drying	Electricity	Hot air	100	Solar air heaters
Tempering in furnace	Natural gas	Hot air	200	Solar air heaters with Concentrating collectors
Paint shop Preconditioning that is Hot water rinsing of automobile body in paint shop	Electricity	Hot water	40	Flat plate collector
Paint shop that is curing of automobile paint in paint baking ovens	Natural gas	Hot air	200	Linear Fresnel concentrating collectors
Paint shop air-conditioning of wet paints in the paint shop	Natural gas	Hot or Cold air supply	50	Evacuated tube collectors based chillers
Paint shop evaporation drying	Natural gas	Hot air supply	100	Solar air heating

6.0 Proposed SIPH System for Automobile Industry

Proposed system combines the direct steam generation concentrating collectors with the fossil fuel fired high pressure boiler. Two main components of the proposed system are steam boiler and a concentrating collector field.

Tubular steam boiler is used for steam generation with fossil fuel firing in case of non sunshine hours to give system high reliability. Concentrating solar thermal collector foiled is used as solar boiler for industrial process heat applications. [6]

The efficiency of these collectors depends upon various factors like:-

(i) Geographic location
(ii) Operating conditions i.e. operating temperature and corresponding heat losses
(iii) Field layout
(iv) Orientations of collector field

Concentrating solar collector field is mounted on the roof of an industrial production site to solarise the supply of saturated steam into steam network. Figure 8 shows the layout of the proposed system for integration of solar with fossil fuel fired steam generation system for industrial process heat application in automobile industry.

Concentrating solar collector field supply saturated steam to steam lines which supply heat to various thermal loads.

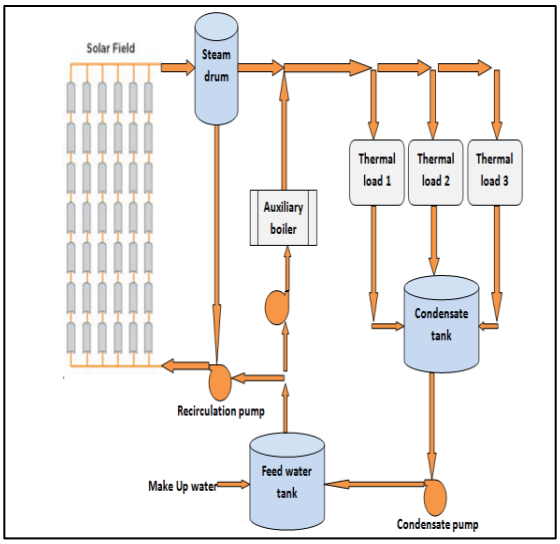
For producing saturated steam, liquid water enters solar field, is heated up to boiling point and beyond also and stars evaporating. Water steam mixture leaving the solar field enters the steam drum where separation of steam from liquid water takes place.

A pump recirculates the liquid water out of the steam drum back to the solar field. Evaporated water is being replaced by feed water pump from the feed water tank.

The water is circulated until the pressure and the related temperature) is sufficient enough for the application.

Then Steam supply starts. The main steam line supplies various thermal loads in the automobile production line for degreasing of automobile parts, heat treatment in furnace , curing of paint in paint shop,etc. [7]

Fig 8: Layout of the Proposed Siph System for Automobile Industry



7.0 Conclusions

Thus solar thermal technology can be installed in the most automobile industrial sectors to lower consumption of fossil fuels, cut production costs, preserve environment by lessening CO2 emissions. Also Commercial viability of solar technologies is much higher for industries using furnace oil, coke or captive diesel based electricity. However Major challenges before solar industrial process heat market development in India are like:-

(i) Low payback period usually expected by the industry
(ii) Missing awareness about this technology in industry
(iii) Lack of solid policy by the government
(iv) Missing pilot projects showing these technologies success here in India.

Aim of this paper is to develop solar-fossil fuel steam generation system for industrial applications for a more sustainable production in sectors such as automobile, food, textile, pharmaceutical and many others.

This system consists of two main components: a solar concentrating collector field and a conventional steam boiler.

With this system, integration of saturated steam supply for process heat applications in a reliable, energy efficient and cost effective way is possible.

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