# Waste Heat Recovery

Getting more out of diesel gensets

Long power cuts and rising oil prices are significantly affecting the profit margins of industrial units, which are operating gensets in continuous mode. Waste heat recovery from gensets is a technological trend being adopted by industries requiring process heating/cooling.

In the conventional diesel genset, about 43 percent heat energy is converted into electrical energy. The balance is thermal loss and waste heat, which gets released through the jacket water, lubricating oil, exhaust gases, heat exchangers and cooling towers. Small modifications to recover this waste heat could result in significant monetary savings each year for the manufacturing units.

Here are some examples of how to achieve such cost saving….

## Recoverable waste heat energy

*Exhaust gases:* about 47,000 kg per hour of exhaust gases are released in a 6 MW genset run on HFO. These gases are passed to the atmosphere at about $350^0$ C. This temperature can be brought down by $180^0$C by using the vast quantity of heat through waste heat recovery boilers or hot water recovery units depending upon the end requirement of the manufacturing unit. However, it must be ensured that the exhaust gas temperature does not fall below the dew point – $160^0$ C – when it will form $H_2SO_4$ after condensation and damage the chimney of the genset.

Similarly, a 6 MW genset running on furnace oil produces about 46,000 kg per hour of hot gases at about $350^0$C. This exhaust heat energy can be converted into the following:

- Saturated steam of 2,200 kg per hour at $180^0$C and 10 bar pressure. This quantity is sufficient to generate 550 TR in the vapour absorption machine. The heat recovery unit and 550 TR VAM cost about Rs 12 million. The payback period at this cost level is less than one year.
- The water flow rate of 120 cu. meters per hour can be raised up to a temperature of $180^0$ C. this can operate a VAM of 550 TR. (Hot water should be subjected to 12 bar nitrogen pressure.)

*Engine water jacket system:* this system consists of 200 cu. metres per hour flow rate of water of $90^0$C at the engine outlet. This heat energy ($\Delta_T$ = $100^0$ C) can be used by feeding into a 450 TR VAM. A single-cycle 450 TR machine with pipes, etc. costs about Rs 12.5 million. This gives a payback period of less than one year.

*Lub-oil centrifuge:* the inlet and outlet oil of the lub-oil centrifuge can be passed through a common heat exchanger. This process can raise the centrifuge inlet oil temperature by $100^0$ C. the best lub-oil temperature for centrifuging is $900^0$ C. there is good energy saving in this process. The heat exchanger costs less than Rs 50,000 and this cots can be recovered within one month.

## Use of recovered energy in power plants

*Steam/Hot water heating of HFO tanks:* Electrical heaters can be replaced with steam heaters / hot water coils. This modification can save up to 90 kW on a continuous basis HFO-based power plant of 6 MW. The net yearly saving on account of electrical energy is about Rs 3 million. The initial conversion cost is about Rs 1 million.

*Recycling of sludge oil:* HFO consumption of 100 metric tones per day generates about 1,000 kg of sludge oil. Out of this, 400 litres of good fuel is recoverable by the heating and centrifugal process. At current prices, the recovered HFO is equivalent to about Rs 2 million per annum.

## Other cost-saving avenues

In addition to recovering waste heat, deviations in genset operations could increase the specific fuel consumption (see accompanying table). Measuring genset performance is important for achieving lower deviations.

Usually, gensets operate at less than full load. This results in higher specific energy consumption. Increased loading along with inlet air cooling can improve the operational efficiency of gensets. Frequency and voltage optimization also improve energy savings in process industries.

| Recommended improvements in gensets for cost savings | |
|---|---|
| Operational deviation | Increased specific fuel consumption |
| $\Delta_P$ Air intake filter (+50 mm $H_2O$) | + 2 g/kWh |
| $\Delta_P$ Charge air cooler (+100 mm $H_2O$) | + 2 g/kWh |
| LT cooling water temperature (+ $100^0$ C) | + 3 g/kWh |
| $\Delta_P$ Turbochargers turbine side (+50 mm $H_2O$) | + 2 g/kWh |
| $\Delta_P$ Exhaust gas pipes (+ 100 mm $H_2O$) | + 2 g/kWh |
| **Fuel** | |
| (a) water contents +1 per cent | + 2 g/kWh |
| (b) heat value (-) 500 kJ/kG | + 2.5 g/kWh |
| (c) Faculty injector nozzle | + 5 g/kWh |
| (d) Worn-out injector pump element | + 5 g/kWh |

Based on inputs from S.S. Parmar, Vice-President, Energy Group, Flex Industries Limited

**Reference Book:**

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