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Energy efficiency

Sustainability and savings in old plant

The necessity to reduce emissions and to optimize energy consumption has created a demand for eco-sustainable and high efficiency products. However, upgrading and performance testing of old, inefficient plant rather than replacement can offer better results. At a desalination plant this led to energy savings which equated to a reduction of 7,630 tons of carbon dioxide emissions per annum.

The necessity to reduce emissions and, concurrently, to optimize energy consumption has created an increasing demand of eco-sustainable and high efficiency products.

In this regard, a large number of industrial projects, related to plants or machines themselves, which combine high performances with low emissions have been developed.

This trend, however, tends to exclude the 'existing' installed base, that is to say the products, machines or plants which, having been designed and built quite a while ago, result either inefficient or polluting.

Looking ahead, we have to take into account that a large number of energy efficiency possibilities can also be adopted for up and running plants whose commercial life is scheduled to last from 20 – 30 years.

The graph (Figure 1), quoted by the European Renewable Energy Council in their 2009 report, confirms the importance of such possibility. In fact, the graph illustrates a potential scenario whereby the world will consume almost 40,000 terawatt-hours (Twh) per annum of additional energy in 2050.

Yet, the graph also shows that, in this scenario, the overall non-renewable energy component will be reduced to less than 10,000 Twh per annum – i.e. less than half of its current amount, one of the key factors allowing to achieve such result being energy efficiency.

A brine recirculation pump for a desalination plant, retrofitting of the pumps and re-testing of their performance exceeded expectations, with an enhancement in efficiency of to 9.8%, yielding an energy savings of 1.5 MW.

Indeed, the graph shows that energy efficiency represents half of the potential to address carbon footprint on the planet in the short- to mid-term period.

Increasing energy efficiency

Improving the energy efficiency of existing plants may initially seem easy, as easy as changing machines by stimulating their purchase through public funding for example, but in reality, the situation is much more complex.

First and foremost, large plants cannot simply be 'scrapped' without, in their turn, causing a great environmental impact nor generating very high costs which turn out to be unsustainable, whether by their owners or governments themselves whom have to face tighter and tighter budgets each year.

Furthermore, machines such as pumps, compressors, etc. often represent a plant's 'beating heart'. As such, their substitution, as made-to-measure parts of the structure

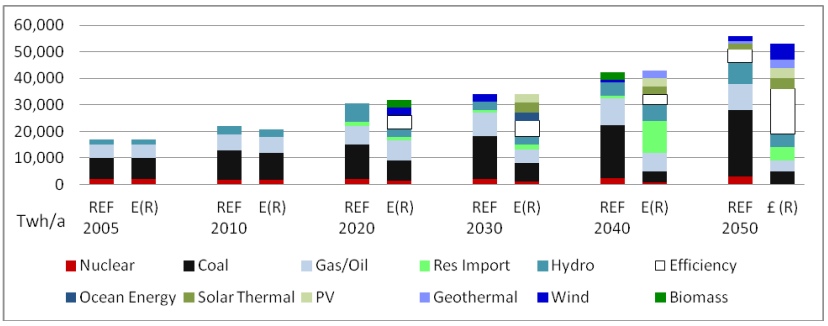

Figure 1. Energy development scenarios 2010-2050.

hosting them, if not the other way around (i.e. a structure built around the machine), results in most cases very costly, if not dangerous for the operations of the plant itself.

Due to the above considerations, the most effective solution is therefore to change only the core components of the machines which have an impact on efficiency of operations (for example hydraulic parts such as impellers, diffusers, etc.), leaving the other components' mechanical and operational interfaces with the plant unchanged.

Proceeding this way, the main benefits for the plant are as follows:

- direct benefits due to reduction of energy consumption
- indirect environmental benefits such as reduction of CO2 emission
- indirect benefits due to the increasing of operational efficiency with reduction of wears and spare parts substitution
- easy installation and implementation of the upgraded machines, without modifications on the plant interfacess.

As a result, the initial investment cost gets quickly returned over a few years, making such solution a "zero-cost" one for the plant.

TM.P. S.p.A. Termomeccanica Pompe experience

TM.P. S.p.A. Termomeccanica Pompe is a designer and provider of engineered pumps and global service solutions with a century of experience. Over the past five years, TMP has indeed developed many projects related to energy saving, supporting its customers in choosing the best solution tailored to their real plant needs.

More specifically, the pumps solutions offered are designed for the power generation, desalination and water handling sectors and range from the simple upgrading of a single component to the refitting of an entire pumping station, including design, manufacturing, supply, installation and commissioning activities.

Figure 2 reports Termomeccanica Pompe's main references in energy saving projects implemented over the last five years.

Case study

The last of the projects listed in Fgure 2 is actually one of the most complex and ambitious energy saving project ever implemented in pumping systems.

The desalination plant, officially inaugurated in 1979, consists of six MSF distillers, each having a capacity of 5 MIG, and is equipped with twelve brine re-circulation and six seawater supply pumps. Thanks to good operational and maintenance standards and practices, the pumps and all other major equipments have remained in rather good operational conditions.

However, considering the substantial progress made in pump design and operating efficiency since the desalination plant was commissioned 32 years earlier, the end user decided in 2010 to study an energy saving project related to the plant's pumps.

The outright replacement of entire pumps was not taken into consideration as not financially justifiable for what was initially expected to be only an incremental efficiency gain.

For this reason, the end user chose to study the possibility to only change some components of the major power consuming pumps installed, such as the brine recirculation and sea water pumps.

As the company whom originally supplied both types of pumps had shifted its business to other types of machinery over the years, it could not offer support to the customer for this project.

End User	Plant type	Location	Energy Saving Project
Enel	Power plant	La Casella - Italy	insertion of variable speed coupling
Enel	Power plant	Priolo - Italy	insertion of variable speed coupling
Enel Green Power	Power plant	Larderello - Italy	rehabilitation and spare hotwell pumps
Tirreno Power	Power plant	Vado Ligure - Italy	up-rating of condensate and circulation pumps
CAV (Costruzioni Arsenale Venezia)	Dry-docks	Italy	complete pumping station rehabilitation
Endesa Italia	Dam pumping station	Savuto- Italy	complete pumping station rehabilitation
Edipower	Dam pumping station	Mese- Italy	complete pumping station rehabilitation
A.Q.P. (Acquedotto Pugliese SpA)	Aqueduct pumping station	Secli - Italy	pump modification
A.Q.P. (Acquedotto Pugliese SpA)	Aqueduct pumping station	Parco del Marchese - Italy	pump modification
Edipower	Power plant	Chivasso - Italy	insertion of variable speed coupling
A2A	Power plant	Ponti sul Mincio - Italy	insertion of variable speed coupling
ENAS	Pumping station	Simbirizzi - Italy	pump modification
C.E. Rovinari SA	Power plant	Rovinari- Romania	pump modification
ZPC (Zimbabwe Power Co.)	Power plant	Hwange - Zimbabwe	pump modification
SWCC	Power & Desalination plant	Al Khobar - Saudi Arabia	sea water pump modification
SWCC	Power & Desalination plant	Jeddah- Saudi Arabia	sea water pump modification
DUBAL	Desalination Plant	Dubai	Sea water & brine recirculation pump modification

Figure 2. Termomeccanica Pompe's main references in energy saving projects implemented over the last five years.

Pump	Head (m)	Flow (m3/h)	Speed (RPM)	Power (kW)	Efficiency (%)
Design	67	5,309	980	1,243	81
Factory test post-upgrade	67.5	5,309	993	1,144	88.7
Site test post-upgrade	66	5,309	990	1,120	88.6
Energy Saving (post-upgrade/design)				-123 KW eq. to 9.8% saving	

Figure 3. Summary of the detailed results related to the brine recirculation pumps.

Hence the idea to search the market for another pump manufacturer able to substitute the key components of the machines (such as the impeller and pump casing), leaving the others unchanged (for example shaft, sleeves and discharge column), respecting their existing physical and functional interfaces.

By proceeding this way, the objective was to give a 'new life' to the existing pumps, reducing their operating costs as well as maximizing the energy saving/ investment ratio.

Termomeccanica Pompe, using its own R&D resources, performed a extensive engineering study and proposed two high-tech solutions for the sea water and brine recirculation pumps. All the latest technical developments were used to optimize the hydraulics of the pumps, maintaining the existing interfaces as well as the existing materials, as per the end user's request. Thanks to these specific characteristics, the expected energy savings for the Termomeccanica-modified machines resulted higher than the ones requested and largely contributed to the assignment of the order to the company by the end user.

The project was executed according to the following phases:

- Site assessment and testing of the pumps to verify the actual pump-performance
- (for some of the pumps, the performance was found to be lower than design, meaning they offered a greater efficiency gain potential)
- Further performance testing on one of the pumps at Termomeccanica's in-house test center (which confirmed the site test)
- Retrofitting of the pumps (new hydraulic components, impellers and casings) and re-testing of their performances up to contractual specifications at Termomeccanica workshop
- On-site installation and final testing.

More detailed results related to the brine recirculation pumps are summarized in Figure 3.

The results actually achieved exceeded the initial expectations, with an enhancement in efficiency of to 9.8%, yielding an energy savings of 1.5 MW which equates to a reduction of 7,630 tons of carbon dioxide emissions per annum.

Conclusion

Such type of pump upgrading project allowed to reach two objectives: energy saving through efficiency increase of the modified pumps and credit generation through the CDM mechanism.

Termomeccanica Pompe is currently involved in other energy saving projects around the world, such as the refitting of turbo boiler feed pumps and complete pumping systems rehabilitations, maintaining in all cases the interfaces with the existing plant system and upgrading the efficiency of the machines involved, thus achieving not only great energy and cost saving for the customer but also benefitting the environment.

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