Duplomatic Oleodinamica in the ENERGY sector









Geothermics



Servo-systems





A brilliant future for the thermodynamic solar energy



Duplomatic Oleodinamica has been maintaining a worldwide leader position in the energy sector: for such a reason it has been involved in the Archimede Project developed by Enea in cooperation with Enel, aiming at producing low-cost, environmentally friendly solar energy. The innovative technology is based on the concentration of the solar energy through parabolic mirrors and on the consequent heating of a fluid whose thermal energy can be stored and used to produce steam, to start the turbines and to generate electricity. Such a process, based on the intuition of Carlo Rubbia, who was awarded the Nobel prize in Physics, uses as heat carrier a particular mixture of molten salts whose temperature can reach 550°C. The first industrial plant employing such a technology is currently under development in Priolo Gargallo (Sicily).

Duplomatic Oleodinamica has realized the sun-tracking collector system, formed by a supporting framework (including shaft and cylinders) and by the hydraulic drive system (including the control panel). The basic criteria of functionality, safety and energy saving have been duly taken into consideration while designing the whole system. The use of NG6 directional proportional valves, type DSE3, together with a customized digital card and a rotary encoder allows the constant tracking of the sun with a position and speed closed loop and with a positioning precision lower than ± 0.8 mrad. Thanks to two pumps the system performs the sun tracking procedures at a speed included between 0 and 45 mrad/min, while the safety position is reached at a ten times higher speed. The structure of the driving tower and the employed hydraulic cylinders allow to keep the pointing accuracy unchanged with a wind blowing speed up to 16 m/s; the stall torque corresponds to 85,000 Nm.

Solare XXI

Formed by four sector leading companies, the Consortium "Solare XXI" is aimed at developing a highly technological and innovative product, i.e. the linear parabolic solar collector with molten salts. Solare XXI represents the Italian technological excellence in the sector: Archimede Solar Energy for the production of the receiving pipe, Ronda High Tech for the realization of the reflective panels, Duplomatic for the motion control system and Techint for the design of the supporting frameworks and the component integration.



Servo-controls on steam turbines

he functioning of the steam turbine is based on the thermodynamics principles: with the expansion the steam undergoes a temperature decrease, because part of its thermal energy turns into mechanical energy with the movement of its forming particles. Such transformation allows the availability of a huge amount of mechanical energy.

The generation of the alternated current requires a precise control of the turbine speed and it is subject to the energy request in the network. Duplomatic developed a series of intelligent servo-cylinders, which can manage the turbine speed with an integrated closed-loop system and control the position of the actuator which determines the opening of the steam valves.

The Duplomatic product consists of:

- Servo-cylinder (custom drawing)
- Proportional valve with two solenoids, integrated electronics (DSE3G Z*/11N-E1K11/D) and 4÷20mA current control
- ERM modular card or EDB box card for the remote control of the actuator position and for the availability of a digital contact when the servoactuator is in target.

Servo-cylinders

Duplomatic boasts a valuable experience in the design of simple or servo-controlled actuators for the energy sector, which is featured by precise needs: reliability, particular designs to be adapted to the most different requirements of steam or gas valves producers, integrated fail-safe condition.

Software

Not long ago the servo-cylinders in the power plants were controlled through traditional Eurocard cards positioned into

> electric cupboards far away from the controlled actuator. Such an analog control implied a good knowledge of the product and the use of a series of measurement tools for the start-up.



Power-pack for steam valves control

The technologic evolution has introduced the use of digital controls which make the start-up easier and are of great help in the possible replacement of the product. But Duplomatic has done even more: it has worked to make the start-up easier, thus applying the "plug&play" philosophy, which implies the realization of a product that is supplied assembled to the servo-cylinder and requires the final user to simply set the "electrical zero" to be combined to the mechanical zero (steam valve). The whole procedure is possible via the CANPC-SOF/ R001 digital tool.

In order to complete the control of the steam turbine Duplomatic has also developed a card for the remote control of the signals necessary to verify the actuator condition – in the control room of the power plants – and the speed of the turbine itself. The card is available both in the modular and in the box format. The latter can be supplied pre-wired and mounted on the actuator.

One of the most remarkable advantages, among the several offered by the Duplomatic solution, is the shorter time needed for the start up; as a matter of fact the "plug&play" solution reduces to the minimum the possibility of errors and thanks to an user-friendly software the final user only has to perform a simple "zero calibration" procedure of the sensor placed on the actuator. The advantages of the digital solution become evident in case of replacement of the proportional valve or of the electronics because it foresees the factory storage of all the data (PID, ZERO, MAX STROKE, DEAD BAND etc.) which can be downloaded in the new product without requiring a new system setting. The CANPC-SOF/R001 software allows to control the servo-cylinder and to perform the diagnostics via the CAN Bus.

Complete servo-system

Hydraulic applications for gas-turbine power plants

Duplomatic Oleodinamica has gained during the years a specific experience in the energy sector by developing and examining some projects in cooperation with sector technicians for the applications of both special components and of gas-turbine dedicated systems which are realized and certified in compliance with the ATEX 94/9CE European Directive for the Area 2 (Category 3).

Adjusting servo-cylinders

They are currently used for 80-160 and 250 MW power plants. Their function is the activation of valves aimed at controlling the flow of the liquid or gaseous



Actuators for turbogas valves

fluid; their task is therefore fundamental in order to guarantee positioning precision and reliability. In order to be up to such requirements, the oil regulation occurs through a high-dynamic servo-valve with a transducer on the loop closure, which assures a centesimal positioning precision to the system. Just consider that 1 millimeter error causes a waste of some MW of electrical energy.

On-off cylinders

They are used for the start of the valves stopping the fuel flow in order to guarantee the safety conditions of the plant; the system foresees a set of disc springs and a circuit which allows the fast discharge of the starting oil. The component has to guarantee the valve complete closure within about 0.2÷0.3 seconds independently of any emergency condition.

IGV servo-cylinders

The function performed by this actuator is the handling of the Inlet Guide Vanes system: such system

regulates the vanes of the first fixed stage of the compressor of a gas turbine, making the vanes rotate in order to change the air flow rate incoming into the machine and therefore also the combustion of the flame into the boiler. The basic features required to this double-effect actuator are rigidity and precision; the closed loop control system is formed by a high-dynamic servo-valve and a position transducer.

Blow-Off actuators

The function performed by this system is the handling of the blow-off valves of the gas turbines. The blow-off valves protect the main compressor of the gas turbine against possible

pumping events or against possible vibrations into the combustion chamber due to undesired transients. The main feature of this actuator is to ensure the required torque at the valve closure but, even more, to guarantee, at any moment and in any operating condition, the emergency opening of the valve itself. The function of the above-mentioned systems is included in the gas turbine enclosure, where the turbine adjustment is performed. This is therefore classified as an "explosion hazardous area" and all the above-mentioned actuators are realized and certified according to the ATEX European Directive for the Area 2.

Power control units

The experience in the design and realization of hydraulic systems in the different energy and industrial sectors allows Duplomatic to supply the whole system by using its own components. The function of the control unit for the power supply of the servo-cylinders requires the use of extremely reliable signaling and emergency components which are manufactured according to strict specifications agreed with the customer. Duplomatic has also the possibility to self-certify the whole plant in compliance with the **PED Certification**.



Turbogas power plant

Energy inside the earth



The geothermal power is stored in the Earth in the form of steam.

Among the different forms of renewable energies, the geothermal power plants allow the installation of the highest powers. The total production of the geothermal power plants corresponds to about 10-17%, which is much lower than the production of the thermal power plants; their advantage is the use of an ecologic and renewable fluid without the emission of carbon dioxide to the atmosphere.

In the dry steam power plants the steam is directly used to turn turbines which are suitable to meet the thermodynamic features referred to the fluid pressure and temperature. Here the potential energy of the fluid is turned into mechanical energy, which is immediately transformed in electric energy via a generator connected to the turbine itself.

In order to reach the highest efficiency the steam must be directed, controlled and measured out. The valves controlling the steam flows are usually started by hydraulic actuators.



Hydraulic system for geothermics

The peculiarity of the plants destined to be used in a geothermal environment consists in the choice of materials resistant to extremely hard weather conditions because of the presence of the hydrogen sulphide.

It implies the study and the realization of ad hoc components realized by using plenty of stainless steel. It is important to remember that also the electric



Geothermic power plant

components, which are generally applied in the hydraulic systems, are subject to a fast oxidation; it is therefore compulsory to use gold-plated contacts or contacts sealed with inert gas (argon), to avoid components made of copper or copper alloys (solenoid special coils), and to favor the use of non-metal covers.

From the '90s Duplomatic has been realizing the power and hydraulic control system aimed at piloting the actuators of the geothermal power plants installed in the area of Larderello.

The hydraulic plants for the 20 MW and 60 MW first-generation geothermal power plants have been realized in cooperation with Ansaldo and Franco Tosi. The design of the hydraulic systems has required the implementation of all the safety measures necessary to guarantee the production continuity with reduced downtimes (only for planned maintenance). The system includes also three motor-pump groups for the stand-by availability, double systems for the turbine trip block in order to guarantee the turbine safety in any fail condition and a series of accumulators to face possible black-outs.

The power of water



By tradition Duplomatic is engaged in the sector of renewable energies. After several applications realized in the geothermal sector from the '90s onward, the company has recently installed systems for the production of wind energy and solar thermal energy. Supporting such new technologies, Duplomatic engaged in the hydroelectric sector for the renewal or installation of new hydroelectric power plants.

The successful cooperation with the company Voith Siemens Hydro Power Generation, leader of the sector both in Italy and abroad, led to the installation of tens of Pelton as well as Francis and Kaplan turbines.



Hydroelectric power plant

The hydraulic systems that power the turbines share a common philosophy as far as power generation is concerned:

- Two motor-pump groups, one of which is auxiliary to the other
- System for filtering and conditioning the off-line oil
- Duplex filter on the common pump delivery
- Split storage unit for the pump alternation and for the fast handling and safety functions in case of voltage drops.

They differ from each other in terms of solutions adopted for the control circuit and for the drives.

In the Pelton plants a closed loop control is performed both on the penstock (functioning as a nozzle) and the deflector (deviating the water flow) using proportional valves with integrated electronics. In the Francis turbine the water reaches the runner from an annular channel and the fixed guide vanes direct the flow towards the curved vanes of the runner itself. The regulation of the turbine is achieved by varying the incidence angle of the fixed guide vanes and this function is regulated by hydraulic servoactuators controlled by proportional valves.

The Kaplan turbine uses very low heads with high flow rates. The water reaches the turbine through an annular channel, is then deflected by guide vanes which give an axial direction to the water that finally acts on the runner. By changing the orientation of the runner vanes it is possible to optimize the rotational speeds

in relation to the different flow rates, maintaining a high efficiency (around 90%). The Hydraulic regulation of the vane angle is obtained by use of proportional valves controlled by position closed loop feedback.

A series of optional hydraulic controls with onoff switches exists for each turbine model which are regularly monitored for the management of upstream and downstream valves and for safety measures.



Hydraulic system for hydroelectric turbines



Control room of a hydroelectric plan

Highest precision for the actuator positioning

he development of hydraulic servo-systems controlling the steam flow or pressure in the thermal power plants is reckoned among the several applications realized by Duplomatic Oleodinamica in the electrical energy production



Servo-controlled valves and hydraulic control panel

sector. The different valve types, all of them with a linear actuation, are defined and dimensioned in order to guarantee the highest compliance with the requirements of functions such as pressure reduction, desuperheating, by-pass etc. Together with the actuator dimensioning, Duplomatic Oleodinamica has developed also the circuitry in order to meet the more and more pressing safety needs of the power plant staff.

The most advanced section of the system is represented by the control circuit of the driving actuators. This application foresees the use of DSE3G proportional valves with integrated electronics and shutting spool for the position control.

A special spool has been designed which is capable to control extremely low flow rates, in order to guarantee the required positioning precision. The valves with integrated electronics have a central position spool with positive overlap: such dead zone is aborted by the electronics as soon as the regulation loop is enabled; as a consequence in case of break of the set point or power supply cable, the valve behaves as a normal closed centre proportional valve with positive overlap.

The programming flexibility of these new proportional valves allowed to take into consideration new solutions to be offered on the energy production market.

The new system allows the in-factory calibration and the recording of the data on the Pc; the advantage is the availability of a common data base which permits, in case of maintenance or replacement of the components, to parameterize the system again by inserting the same gain, dead band, offset data etc. available on the replaced version.

During the emergency or safety phases the easy management of the handling procedures with an off-condition actuator is therefore possible.

Because of the high reliability degree required by this application it has been advisable to apply a further hydraulic safety element. The hydraulic piloted sliding valves form the fast closing circuit and detach the proportional valve from the fail-

> safe circuit. As a consequence the safety function is performed independently of the position acquired by the spool of the proportional valve.

The position transducer can be integrated inside the cylinder or it can be mounted externally with possible signal redundancy obtained by using the ERM electronic card by Duplomatic Oleodinamica. The positioning precision of these servo-systems is very high (some tenth of millimeter) in line with the requirements of the steam sector.

Servo-system for thermoelectric power plants

Turnkey systems for wind power stations



he main targets of a wind power station are to maximize efficiency and performance by optimizing the wind incidence angle on the vanes and to guarantee a steady rotation speed. The control technology of the adjustable pitch propeller plays therefore a key role thanks to the important reduction of the time needed to reach the production peak, which is kept constant even in presence of a variable speed wind.



Wind power stations

Being a worldwide leader in the energy sector thanks to the several projects in the production of solar, geothermal, hydroelectric, gas-turbine and steam-turbine energy, Duplomatic Oleodinamica is in a position to offer a turnkey system representing the most comprehensive and efficient solution to problems related to the generation of wind energy.

The system is made up of a power unit designed to generate the flow rate necessary to the movement of the hydraulic axes; three servo-actuators controlled by proportional valves with digital integrated electronics and synchronized through a field bus for the control of the vane position; two groups controlled by proportional valves with digital integrated electronics for the control of the rotor and holding brakes.

The result is an integrated platform capable to offer important advantages in terms of efficiency

and safety as compared to the traditional electromechanical systems.

Accuracy in synchronism and efficiency

The servo-cylinders automatically vary the vane position according to the wind speed and direction thus steadily maintaining the generator at its highest performance level; the accurate synchronism of the position of the three vanes is ensured by proportional valves with stateof-the-art integrated electronics and reduces to the minimum the mechanical stresses on the structure.

Safety

In case of faults or excessive wind speed, the vane return to the safety position is guaranteed even in case of power drops: the sensors placed onto the safety valves and the control unit allow the control room, wherever it may be, to fully monitor the system functioning conditions.

Compactness

Thanks to its feature of making up the high power density with the extremely reduced dimensions of its components, the system designed by Duplomatic Oleodinamica represents the ideal solution for the installation within the limited space available on the wind towers.



Actuator for pitch control

REFERENCES

Ansaldo Energia Assea C.G.M. Cover Idroelettrica De Pretto Edison Termoelettrica Electrobell Enea Enel Elvi Fiat Avio Fiat Engineering Foster Wheeler Italia Franco Tosi Geico Hydroenergy Parcol Siemens AG Turbo Care Vatech **Voith Siemens**

Alstom Siemens

parabolic trough solar collector





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