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High-Pressure Steam Turbine for Medium-Scale Concentrated Solar Power Plants

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Abstract : Many efforts have been spent in the design and development of Concentrated Solar Power (CPS) Plants worldwide. Most of them are for on-grid electricity generation and they are large plants which can benefit from the economies of scale. Nevertheless, several potential applications for Small and Medium-Scale CSP plants can be relevant in the industrial sector as well as for off-grid purposes (i.e. in rural contexts). In a wide range of industrial processes, CSP technologies can be used for heat generation replacing conventional primary sources. For such market, proven technologies (usually hybrid solutions) already exist: more than 100 installations, especially in developing countries, are in operation and performance can be verified. On the other hand, concerning off-grid applications, solar technologies are not so mature. Even if the market offers a potential deployment of such systems, especially in countries where the access to grid is strongly limited, optimized solutions have not been developed yet. In this context, steam power plants can be taken into consideration for medium scale installations, due to the recent results achieved with direct steam generation systems based on paraboloidal dish or Fresnel lens solar concentrators. Steam at 4.0-4.5 MPa and 500°C can be produced directly by means of innovative solar receivers (some prototypes already exist). Although it could seem a promising technology, presently, steam turbines commercially available do not cover the required cycle specifications. In particular, while low-pressure turbines already exist on the market, high-pressure groups, necessary for the abovementioned applications, are not available. The present paper deals with the preliminary design of a high-pressure steam turbine group for a medium-scale CSP plant (200-1000 kWe). Such a group is arranged in a single geared package composed of four radial expander wheels. Such wheels have been chosen on the basis of automotive turbocharging technology and then modified to take the new requirements into account. Results related to the preliminary geometry selection and to the analysis of the high-pressure turbine group performance are reported and widely discussed.

Keywords : concentrated solar power (CSP) plants, steam turbine, radial turbine, medium-scale power plants
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