



High Performance Blading for Steam Turbines

In recent years the development on the energy market has been challenged with liberalization, limitation of primary resources as well as increasing significance placed on environmental protection and reduction of carbon dioxide emissions. Therefore, it is becoming more and more important to make existing power plants more competitive and as efficient as possible. The implementation of innovative technology for existing power plant components, in particular the steam turbine, is one of the main ways to achieve better efficiency.

Blading plays a very important role in turbine efficiency, as it is the blading that converts the energy in the steam into useful energy. Steam turbines are custom-made products. Considerable importance is placed both on their economic viability and their flexibility when it comes to incorporating customer wishes. As the demand for highly-efficient, reliable but customized steam turbines increases, design solutions must not only fulfill the highest levels of performance, but must also provide flexibility of application.

Combining flexibility with reliability is not only important for new steam turbines, but also for upgrades to existing steam turbines. As existing blading technology became incapable of satisfying these requirements, Siemens made considerable efforts in the field of research and development to come up with a technology able to respond to the latest customer requirements.

Our Solution

At the beginning of the 1990s Siemens introduced a three-dimensional blade design which is implemented in all various types of drum stages in high-pressure (HP), intermediate-pressure (IP) and low-pressure (LP) turbines. These drum stages



Fig. 1: 3DS blades

are equipped with twisted, bowed blades designated 3DS™* blades (3DS: three-dimensional blades with reduced secondary losses).

The three-dimensional design approach developed by Siemens has provided a flexible solution offering a wide range of applications. The design is also intended to minimize profile, secondary and tip losses in the turbine blade stage. This results in significant improvements in blade efficiency (up to 2 % as compared to conventional blade designs).

A few years later Siemens developed a further, innovative blade design technology which they designated 3DV™* (3DV: three-dimensional blading with variable degrees of reaction). This technology optimizes the blade path using automated computational methods. This allows stage reaction and stage loading to be incorporated in the design (see Fig. 2). This can further enhance blade efficiency, up to 1 % higher than for comparable blades designed using conventional methods.

* Siemens patented design and trademark

Performance Enhancement – Steam Turbine

Answers for energy.

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Features

Design system

The automated design system uses proven standard geometries for blade root, blade profile as well as seals and combines these to provide an individual blade path design. In-depth parametric studies were performed on the design of the standard elements to allow these to be used flexibly. These studies made extensive use of state-of-the-art design methods (CFD and FE). Empirical investigations also served to validate the results. As a generic approach was adopted for the design system, drum stages can be designed for HP and IP turbines, as well as for LP front stage groups for a large range of applications.

Design Features

The blade stages are designed as reaction stages, whereby the degree of reaction can be varied. The first stage can be designed with low reaction to reduce the temperatures in the downstream blade rows.

The highly-stressed nozzle ring is fabricated as an integral ring with the nozzle airfoils arranged diagonally to optimize steam admission flow.

In addition to the qualitative advantages of a standardized design process, incor-



Fig. 4: Reaction stage

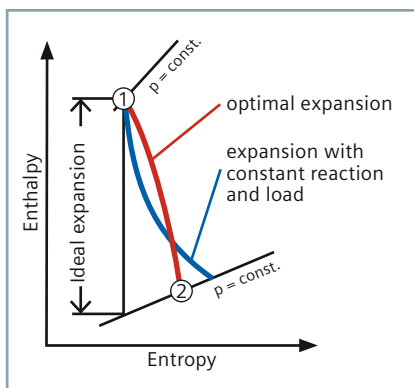


Fig. 2: 3DV Design Concept

porating 3DS (reduced secondary losses) and 3DV (variable stage reaction) technology, results in most cases in optimum blading solutions providing higher efficiency and excellent operating behavior.



Fig. 5: Nozzle Ring

These enhanced design methods can also be used effectively when modernizing existing turbines, as the design system will find the best solution within a limited design envelope.

Customer benefit

Upgrading existing steam turbine plant using the new blade technology can make an appreciable difference in the economy of operation of your power plant. The new blading designs can offer the following advantages:

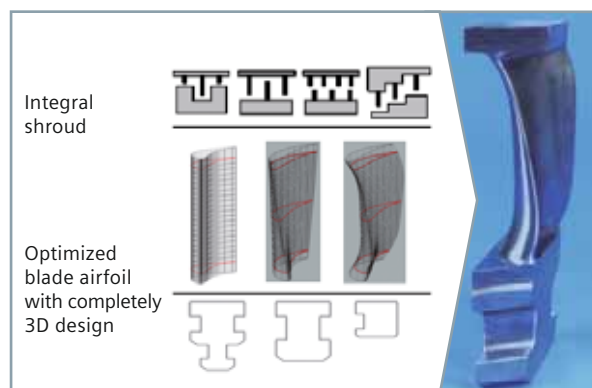


Fig. 3: Design of a 3D Blade Airfoil

- Significant increase in efficiency together with high reliability and operational availability
- High operational confidence due to proven design based on over 50 years' operating experience
- Customized designs for various applications to provide higher performance and economy of operation
- Lower maintenance costs

References

Siemens activities in the field of plant upgrades and new plant business provide numerous references for innovative blade technology (see also product inserts "Mehrum, Germany – Steam Turbine Generator Upgrade" and "Altbach, Unit 1, Germany – Steam Turbine Modernization").

For more information please contact your local Siemens sales representative.

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