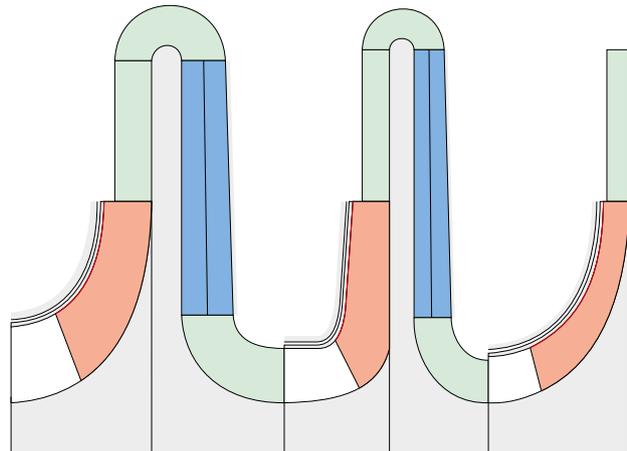


# Performance Rerates



Sulzer is your global partner with reliable and sustainable solutions for your key operations. We offer repair and maintenance services for turbines, compressors, pumps, generators and motors. We also offer OEM and aftermarket parts. With one of the largest service networks in the industry, we are close to our customers with over 180 production facilities and service centers worldwide. Our cutting-edge engineering services provide unique and innovative solutions customized to your equipment needs.

## Steam turbine rerate

The customer operating the ammonia plant has determined that there is additional steam flow available and decided to utilize it to increase power output of the steam turbine to boost production capacity of the ammonia compressor. The turbine is originally rated for 15'000 hp, rotational speed is 11'066 RPM, inlet pressure 600 psig, inlet temperature 720°F, condenser pressure - 5" of mercury. During feasibility study Sulzer determined that the increase of the power output to 17'200 hp can be achieved with the steam available (15% increase to the original flow rate) and the customer decided to pursue this option. The customer asked Sulzer to modify the turbine in order to increase rated output of the turbine. (The customer previously assessed that the compressor has an additional capacity to handle such increase).

The turbine was received in Sulzer shop in La Porte, TX, and dimensional survey of the steam path was performed. Baseline model of the machine flow path was generated in aerodynamic performance analysis software and the collected dimensional data is validated by matching the outputs to the known turbine ratings. Then, based on the baseline analysis results it was determined that the nozzle and 2nd stage diaphragm need to be modified in order to increase power output of the turbine. New dimensions and airfoil shapes for nozzle and 2nd stage diaphragm were calculated and designed to eliminate choke points and enable higher flow rate through

the turbine required to achieve the increased power output. The designed nozzle and diaphragms vane profiles were provided for manufacturing of new parts.

New stationary components along with the refurbished rotor were installed in the case and the turbine produced the target power output of 17'200 hp, boosting the ammonia producing capacity of the plant.

### Equipment rerate and design upgrade for:

- Optimized performance
- Increased efficiency



Equipment rerates for new operating conditions



Perform upgrades and increase efficiency

## Centrifugal compressor impeller geometry recreation

Three stage centrifugal compressor (8'400 rpm) used in the chlorine service suffered a catastrophic failure in operation (chlorine fire inside of the case) resulted in almost complete destruction of the 2nd stage impeller. The customer requested Sulzer engineering team to re-engineer the impeller dimensions and vane shape to match the original performances of the compressor in order to be able to manufacture a replacement part.

The compressor gas path components (impellers and diaphragms) were reverse engineered using coordinate measuring machine and hand measuring tools. The customer provided the OEM performance curves along with the plant operating data to be matched. The compressor gas path was modeled in aerodynamic performance analysis software and

initial dimensions of the 2nd stage impeller were inferred based on the available data. Then, performance curves for the compressor were calculated and the subject impeller geometry modified accordingly to match the target operating points. After a few iterations the calculated performance curve matched the operating data provided by the customer and final geometry of the 2nd stage impeller was obtained. 3D model of a recreated impeller (backplate and coverplate profile, vane shape) was exported to CAD file and then finalized for manufacturing.

The re-engineered stage two impeller was installed on a newly manufactured shaft and the refurbished compressor has been commissioned in July 2016. Performance testing performed on the compressor showed very close matching of its operational characteristics to the original design.



Upgraded design and increased efficiency

### Engineering services capabilities/service offering:

- Alignment tracking
- Machinery diagnosis
- Field balancing
- Performance rerates
- Technical upgrades (blade design improvements)
- Root cause failure analysis
- Rotordynamic analysis
- Turbomachinery engineering seminar series



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