# CASE STUDY

## Improved Reliability and Lower Cost of Ownership with Active Magnetic Bearings

### PROJECT OVERVIEW

With over 20 years of experience Lukoil, a leading oil & gas business of Russia, aspired to expand oil & gas fields in Russia. For the expansion, Lukoil decided on the Bolshekhetskaya depression in West Siberia where large deposits of Cenomanian gas lay.

Developing and constructing a compressor station to connect fields would increase the total capacity of the pipeline. The compressor design had to produce a very high discharge pressure. In addition to the pressure gain required to compensate for the piping frictional losses, the discharge pressure of the compressor also supports a refrigeration process applied to the gas at the plant outlet. This refrigeration process, based on a throttling principle, is required to cool the gas sufficiently to avoid the buried piping temperatures from thawing the permafrost. The permafrost helps maintain a stable support for the buried piping.

### SOLVING THE CHALLENGE

Lukoil partnered with Sumy Frunze, an oil and gas equipment manufacturer, to develop centrifugal compressors for the endeavor to withstand the frigid Siberian conditions. The compressors would give the station the ability to pump 12 billion cubic meters of gas per year to another station, furthering the central gas pipeline of Russia. In support of the unique refrigeration process, providing such high compressor discharge pressures with reasonable drive power requires compressors with very high efficiency.

The high efficiency was achieved with a compressor rotor shaft with a high slenderness ratio. This high slenderness ratio allows high efficiencies, but results in a very flexible compressor rotor shaft. The Lukoil compressors have the most flexible rotors ever equipped with magnetic bearings. The industry leading processing power and advanced control algorithms used by the Waukesha Magnetic Bearings® (WMB) electronic controller were required to make these machines a success. WMB's Multiple Coordinate Control (MCC) algorithm was used to stabilize all compressor rotor natural frequencies, with robust stability margins.

After installation, the product proved to perform. Within the centrifugal compressor, the magnetic bearing technology was engineered to reveal a savings in energy, ecology, and money on the total cost of ownership for Lukoil. The AMB system

### AT A GLANCE

**Industry:**

- Oil & gas: mid-stream natural gas application

**Application:**

- Five 18 MW centrifugal compressors, each equipped with a set of active magnetic bearings

**Product Solutions:**

- Digital components to replace analog cabinet

**Benefits:**

- Energy savings
- Lower maintenance and operating costs
- Lower total cost of ownership
- Improved reliability

has an expected life of 25 years. The primary advantage for the end user over this time period is lower maintenance and operating costs, and improved reliability compared to fluid film bearing solutions.

The Sumy Frunze compressors equipped with the WMB magnetic bearing technology allowed Lukoil to continue with their nine-year development strategy, which started in 2005. Prior to this installation, Sumy had used AMB systems from other vendors; this equipment included analog components within the controller tuning circuitry. WMB was able to eliminate the physical act of connecting and disconnecting analog electronic components by using standard WMB digital technology, that is adjusted and calibrated by quickly changing software parameters.

## PERFORMANCE IS WHAT COUNTS

The Lukoil site is located in western Siberia and is isolated from all public utilities. All electric power must be generated on site. It is not unusual to lose all the power on the site. During these outages, conventional equipment such as lube oil skids, required for fluid film bearings, will drop well below operable temperatures. The time required to heat this equipment and the oil reservoirs back to operable temperatures can be four hours or more. This type of down time risk was completely eliminated by using magnetic bearings for the compressors.


The magnetic bearings can be re-activated within minutes after site power outages. This greatly increases the availability of the compressors. Following the 2013 installation, both gas production and the total production of hydrocarbons were on track to increase by 42 billion cubic meters and 25% respectively by 2014. It is now possible for 12 billion cubic meters of gas to be transported from the newly constructed compressor station, to the main station, and ultimately to the central gas pipeline in Russia.

## VERSATILITY

There is still a capacity for similar WMB bearings to be utilized in other applications. In fact, the success of the 6 stage centrifugal compressors led Lukoil to pursue implementing the WMB technology on a booster compressor station in the same gas field. Other applications include turboexpanders, motors, generators, pumps, steam turbines, gas turbines, and blowers.




233C02-ENUS MY19