Energy consumption in China is rising, following the pattern of its booming economy. On one hand China has abundant coal resources, on the other hand it is obliged to import crude oil that is very expensive.

The Chinese Inner Mongolia region has immense reserves of high-quality coal in the order of 850 billion tons (770 billion tonnes) with very low sulfur content. Although the liquefaction process is energy intensive — 5.5 tons (5 tonnes) of coal converts into only 1.1 tons (1 tonne) of liquid — reserves are so vast that they allow a very long conversion period.

China’s government has decided to establish a number of coal-to-fuel, coal-to-chemicals and coal-to-fertilizer plants in the area using conversion processes from Sasol and Shell as well as one developed in China by Shenhua, one of the largest coal companies with 441 million tons (400 million tonnes) extracted in 2012.

These processes require coal oxidation, which is based on the availability of large volumes of oxygen.

Engineering companies that specialized in air separation units (ASU) have developed processes sized for the steel industry with a maximum of 2755 tpd (2500 T/d) of oxygen per line.

To reach an economy of scale in gas-to-liquids and/or coal-to-liquids (CTL) processes, the size of oxygen produced per ASU line must grow to 7700 to 8800 tpd (7000 to 8000 T/d).
The amount of compressed air required to feed such lines has thus increased from 17.6 MMcfh (500,000 m³/hr) to 53 MMcfh (1,500,000 m³/hr), which can only be efficiently achieved by developing a new generation of compressors.

Scaling up the existing compressor generation would have entailed machines so large they would be practically impossible to manufacture and transport to the site.

MAN Diesel & Turbo (MDT), a leader in the supply of ASU compressors, has developed the MAX1 compressor, together with MTU Aero Engines of Munich (see COMPRESSORtech², August-September 2010).

The MAX1 is a six-stage, axial-flow compressor featuring a modern aerodynamic design mounted on a conventional structure (rotor and stator) in line with MDT’s industrial design required for this type of application.

MDT has used the MAX1 to develop a line of axial/radial main air compressors (MAC) followed by booster air compressors (BAC) capable of serving all ASU sizes presently in the development stage.

The line ranges from the Airmix S (small) for ASUs with a 3300 tpd (3000 T/d) oxygen production to the Airmix XL for ASUs of 7700 tons (6985 tonnes) or larger.

The marketplace has shown a tangible interest in this approach. MDT received orders for four Airmix S trains, for nominal output of 3300 tpd (3000 T/d), featuring an AR105 MAC in January 2012. Last March it got an order for 11 Airmix Ms, featuring an AR115 MAC for 3750 tpd (3400 T/d) ASU. The value of the latest order was more than €125 million.

The four Airmix S trains ordered by Air Products and Chemicals for the Yankuang Group’s industrial complex near Yulin are served by an AR105/06M MAC in its standard design point featuring six axial stages followed, after the intercooler, by one radial stage featuring a 3-D shrouded-type impeller, to deliver the air at a pressure ratio of 6.3.

The Airmix and was developed in a cooperation between MAN Diesel & Turbo and MTU Aero Engines, Munich.

The compressor has a capacity of 18 MMcfh (510,000 m³/hr) and absorbs 42,100 hp (31.4 MW) supplied by a DK080/190R steam turbine that is directly coupled, at 4530 rpm, on the exhaust side of its shaft. On the high-pressure shaft end, the steam turbine shaft is connected to a pinion shaft of the integrally geared booster compressor. Capacity control is achieved by four rows of variable guide vanes on the MAC and two variable inlet guide vanes on the booster compressor.

The configuration of the 11 trains for the 3750 tpd (3400 T/d) Airmix M lines ordered by Linde and Hangyang for the new Shenhua Ningmei plant, in the Ningxia region, is the same as the Airmix S, but featuring an AR115/06M MAC handling 23 MMcfh (650,000 m³/hr) of air with a power consumption of 53,640 hp (40 MW) for
design conditions. The MAC is driven by an 81,800 (61 MW) steam turbine type DK080/250R coupled, at the high pressure end to the BAC six-stage integrally geared compressor.

While MAC and ST are fully assembled in Oberhausen, the BAC will be supplied by MDT’s Berlin location.

All 11 Linde and Hangyang trains will receive their final mechanical tests in Oberhausen, Germany before shipment to China. The Shenhua Ningmei complex, operated by the Shenhua Ningxia Coal Industry Group Co. Ltd., will be one of the world’s largest CTL plants. Credit Suisse has reported that China has 30 large-scale CTL projects in planning, permitting or in the feasibility study stage. CT2
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