Axial Flow Compressor
Footprint Solution
Next Blading Generation MAX1
Today's Agenda

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1 Introduction
Introduction

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MAN Energy Solutions China Co., Ltd.

- Diploma Mechanical Engineering
- Diploma Economics
- PhD in Jet Propulsion Engines Research
1 MAN Company Profile
MAN Company Profile

A worldclass product portfolio

### Marine Systems
- Two-stroke and four-stroke engines for marine applications
- Propellers and complete propulsion systems incl. fuel gas systems
- Turbocharger

### Turbomachinery
- Compressors, gas and steam turbines, expanders
- Complex machinery trains
- Chemical reactors

### Power Plants
- Two-stroke and four-stroke engines for stationary applications
- Diesel and gas power plants

### Service: MAN PrimeServ
- Worldwide network of service hubs: 24/7 OEM service around the globe
Decarbonization & Environment
Respecting the future

- Environment protection
- Technologies developed to reduce emissions and increase the efficiency of your equipment
- Up-to-date upgrades
- Sustainable service solutions for your turbomachinery equipment
3 MAN PrimeServ Turbomachinery
MAN PrimeServ Turbomachinery

Service with passion

- We offer worldwide, round-the-clock service 365 days a year
- Our service solutions include spare parts, turbomachinery maintenance and repairs, modular service agreements and individual consulting
- With our revamp and modification solutions, we keep your equipment up-to-date
- MAN quality service for non MAN rotating equipment under our Omnicare brand
- Safeguard availability of your equipment with 24/7 human expertise and remote machine diagnostics
- MAN PrimeServ academies provide expert training, developing the operational and maintenance skills required
MAN PrimeServ Turbomachinery

Applications

**Upstream (Production)**
Compressors, expanders, gas turbines

**Midstream (Transportation)**
Compressors, gas turbines

**Downstream (Processing)**
Compressors, expanders, steam turbines, gas turbines, reactors

**Industrial Products**
Compressors, vacuum blowers, reactors

**Industrial Gases**
Compressors, steam turbines, reactors

**Industrial Power Generation**
Compressors, gas turbines
4 Local Topics
Turbo Forums in the Region Asia Pacific

Interactive and Tailor-made Seminars – “Keep in Touch with the Experts”
Axial Flow Compressor
Footprint Solution
Next Blading Generation MAX1
1 Summary
MAN Energy Solutions has introduced the new blading technology MAX1 for leading industrial axial compressors. The compressor blading MAX1 leads to very compact, robust and efficient compressor types:

- Axial-radial compressor AR-MAX1
- Axial flow compressor AG-MAX1

AR-MAX1 and AG-MAX1 can be used as a footprint compressor in existing plants and combine the advantages of many years of experience.
Summary
As-is Situation

There are still many very old axial compressors in operation. This fact is reflected above all in:

- Poor efficiencies
- Reduced availability
- Long downtimes
- Less spare parts available
- Low capacities
- High maintenance costs
- Problems with surging
Summary
Service Solution

With the AG-MAX1 and AR-MAX1, MAN Energy Solutions offers a complete footprint solution for your existing axial compressor with:

- Improved efficiency
- Compact and robust design
- Higher availability and reliability
- Increased capacity possible
Summary

Benefits

With our axial compressors AG-MAX1 & AR-MAX1 as a footprint solution you will benefit from:

- Higher efficiency
- Higher train availability
- Less weight onto existing foundation
- Lower invest due to compact design
- Experimentally confirmed surge-robustness
- Reduced CO2 – emissions
2 Detailed Description
Detailed Description
Confirmed Blade Robustness

The MAX1 blading combines the benefits of conventional industrial compressors and gas turbine compressors and was developed in collaboration with MTU Aero Engines (MTU).

Today’s calculation and simulation technologies that were confirmed by extensive tests, verified high blade robustness against:

- Surges
- Choke flutter
- Rotating stall
- Unexpected resonance excitations
Detailed Description
Proven Design with New Blading Geometry
Detailed Description

Small and Light Design

Allowing a ~30% higher rotating speed, the MAX1 blading technology allows for a smaller and lighter design compared to the conventional design (AV, BOGAS):

- Smaller frame size
- 33% decrease of axial stage count
- No radial end stage necessary
- Only 4 variable guide vanes

Size comparison of redesigned axial compressors, ending with MAX1

\(^1\) Suction volume flow of all of three types approx. 400,000 m³/h
Your electrical motor has to be replaced? Think of a 4-pole motor instead of a 2-pole one. You will have the following advantages:

- 16% smaller and thinner (~7%)
- 30% lighter
- 15% less noisy
- High motor efficiencies (97.7 – 98.3%)
Detailed Description

Scope of Supply

MAN PrimeServ provides the following services:

- Comprehensive engineering for compressor footprint solution
- Leading axial flow compressor with MAX1 blading technology incl. sensors
- Delivery of full package to site
- Installation work (optional)
Detailed Description

Implementation

The old axial compressor has to be replaced by a new AG-MAX1 or AR-MAX1 compressor:

- Installation work performed by MAN PrimeServ
- Estimated shut down time will be approx. 3 to 5 weeks
- Delivery time will be approx. 15 months
Detailed Description

References – LULEAX

Modernization of existing blast furnace blower with complete new compressor arrangement:

- AG080/09M, L4 (280.000 Nm³/h)
- E-Motor driven
- Location: Sweden, Europe
New blast furnace blower with complete new compressor arrangement:

- AG080/11M, L4 (290.000 Nm³/h)
- Steam turbine driven
- Location: Netherlands, Europe
Detailed Description

References – DOLVIMAX

New blast furnace blower with complete new compressor arrangement:
- 2x MAX1 AG115/10M, L4 (each 600,000 Nm³/h)
- E-Motor (4 Pole) driven
- Location: Dolvi, India
First Nitric Acid plant in the world with MAX1 service replacing the conventional train design (NAMAX)

- 1x MAX1 AG060/09M (3000 Nm³/min)
- No intermediate gear box anymore
Detailed Description

References – SECUNDRA17

Biggest axial flow compressor in the world

- 1x MAX1 AG140/06M, L4 (1,000,000 m³/h)
- E-Motor (4 Pole) driven, motor rating 65 MW
- Replacing two conventional compressors (each 500,000 m³/h)
- Location: Secunda, South Africa
First MAN AG-MAX1 compressor installed in blast furnace

New blading technology provides resistance to surging, choking. By Roberta Prandoni

There’s first for everything and MAN Energy Solutions (MAN) has its AG-MAX1 axial compressor in a new application. MAN’s AG-MAX1 has been installed in a blast furnace for SSAB EMA AB in Sweden for a steelworks operation in Luleå, just south of the Arctic Circle.

According to MAN, its AG-MAX1 is suited for blast furnace blowers, yet this is the first time it has been installed in this type of application. Special applications for its axial plants, liquid nitrogen gas and wind turbines among others. MAN’s AG-MAX1 compressor variants are also now equipped with new blading technology providing the equipment with a compact profile and a high power density to the already heavy-duty design of MAN’s axial compressors.

For SSAB EMA AB, the AG-MAX1 compressor supplied the air needed to inject pig iron at the blast furnaces. While the furnace is operating, which means the filter house must be heated to prevent cold in the air intake. MAN’s head of field service coordination, Germany – Ron Laase explained that the filter house features a conventional heating system: heating the inlet filter, however, creates condensate in the PI pipe, which also requires a heat source.

Designed for 95% availability for the wide project, MAN’s solution is a significant improvement over the existing 65% availability of MAN’s compressor in a steelworks in Europe. The new compact footprint is made possible because of the rotor, which is more than a third shorter and more than 40% lighter compared with returns in conventional axial compressors, the company said.

Asia is another good market for expanding a blast furnace. A compressor train will be commissioned later this year for a steelworks project in India, India, for the country’s largest blast furnace by JSW Steel Ltd., Besantec said. The project includes an extensive pipe layout, which will be handled by local experts. Another Indian customer, Tata, ordered a compressor train that will be installed in a steel in Jamshedpur, Nordrhein, where the installation power for the compressor train will be provided by a steam turbine using waste heat as an energy source.

Compressors in blast furnace operations aren’t without drawbacks, however, one of the main problems in this configuration is the danger of surging and choking, which is something that generally affects conventional axial compressors.

“Surging is an important, blast furnace

choking. While the cause of surging and choking is not eliminated, the new design ensures that the compressor is able to withstand repeated surging, the company said.

The current trend for these compressor trains, Unlomb said, is to use an electric motor as a power source, which ensures more flexibility when coming into operation.
3 Summary
Summary
What you need to know!

Our Proposal
− Replacement of existing axial compressors by MAN’s leading axial flow compressors AG-MAX1 or AR-MAX1

Your Benefit
− Compact and robust design
− Higher train availability and reliability
− Increased efficiency and reduced CO2 – emissions

Next Steps
− Pre-engineering of compressor replacement (footprint solution)
− Proposal for compressor replacement
Disclaimer

All data provided in this document is non-binding. This data serves informational purposes only and is especially not guaranteed in any way. Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.
Thank you very much!