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K-500 turbocompressors: fewer kilowatts and less vibration, without opening the unit

PJSC ArcelorMittal Kryvyi Rih, oxygen production, compressed-air section TsKS-1 · measurements: senior foreman of the compressed-air section, head of the LRZA laboratory, TsETL · approved by the deputy chief power engineer — head of oxygen production V. K. Zhelezniak

Kryvyi Rih, Ukraine · treatment 20 Sep – 12 Oct 2011 · control measurements after 316 and 342 operating hours

PRODUCT

XADO revitalizant gel

for compressors and journal bearings · staged dosing into the oil bath of the running unit

TEST OBJECT

K-500 turbocompressors

machine No. 9 (serial No. 94) and machine No. 12 (serial No. 9380) of the TsKS-1 section

DOCUMENT TYPE

Two test reports signed by the commission and sealed by the plant

UNIT	CONDITION BEFORE TREATMENT	RUNNING TIME AFTER TREATMENT	REPORT DATE
Turbocompressor K-500 No. 9, serial No. 94	Developing defect of gearbox bearing support No. 5: vibration displacement above the permissible level	**316 h**	14 Oct 2011
Turbocompressor K-500 No. 12, serial No. 9380	Critical wear of the gearbox teeth: vibration of all its supports above the maximum permissible level	**342 h**	October 2011

Both machines are operating units of the compressed-air section; treatment was carried out on the run, without dismantling, and no preventive inspection or repair of the gearboxes was performed during this period.

What was repeated on both machines

↓ 2.8-3.1 %

power drawn by the drive under load, 2578-2692 → 2506-2609 kW

↓ 13-73 %

vibration displacement of the bearing supports, at the defective gearbox support 1648 → 136.5 µm

Power drawn by the drive at identical operating modes

UNIT	MODE	BEFORE	AFTER	CHANGE
K-500 No. 9	under load, **26 000 m³/h**	**2578.0 kW**	**2505.8 kW**	**−2.8 %**
K-500 No. 9	idle running	**1300.0 kW**	**1229.8 kW**	**−5.4 %**
K-500 No. 12	under load, **22 500 m³/h**	**2692.0 kW**	**2608.5 kW**	**−3.1 %**
K-500 No. 12	idle running	**1298.0 kW**	**1222.7 kW**	**−5.8 %**

Power was taken from the unit's own electricity meter. Output, rotor current and throttle opening at the control measurement were the same as before treatment.

Vibration displacement of the bearing supports — by component on both machines

COMPONENT AND MEASURING POINT	UNIT	BEFORE	AFTER	CHANGE
Gearbox, support 5 — axial	K-500 No. 9	**1648.0 µm**	**136.5 µm**	**12.1×**
Gearbox, support 3 — vertical	K-500 No. 9	**18.4 µm**	**7.42 µm**	**2.5×**
Gearbox, support 3 — vertical	K-500 No. 12	**8437.0 µm**	**1236.8 µm**	**6.8×**
Gearbox, support 5 — vertical	K-500 No. 12	**8157.0 µm**	**1564.3 µm**	**5.2×**
Gearbox, support 6 — horizontal	K-500 No. 12	**6894.0 µm**	**846.5 µm**	**8.1×**
Turbocompressor, support 1 — horizontal	K-500 No. 9	**65.9 µm**	**57.7 µm**	**−12.4 %**
Turbine thrust journal bearing, support 2 — axial	K-500 No. 12	**6.36 µm**	**2.38 µm**	**2.7×**

COMPONENT AND MEASURING POINT	UNIT	BEFORE	AFTER	CHANGE
Electric motor, support 8 — horizontal	K-500 No. 9	**9.27 µm**	**3.64 µm**	**2.5×**
Electric motor, support 7 — horizontal	K-500 No. 12	**18.6 µm**	**4.38 µm**	**4.2×**
Exciter, support 8 — horizontal	K-500 No. 12	**57.4 µm**	**15.42 µm**	**3.7×**

SENDIG 911 vibration meter, loaded mode, eight bearing supports of each unit in three directions. The range in the header covers 48 vibration displacement measurements, with improvement in 47 of them.

Operating parameters under load

PARAMETER	UNIT	BEFORE	AFTER
Air temperature at discharge	K-500 No. 9	**180 °C**	**174 °C**
Air temperature at discharge	K-500 No. 12	**238 °C**	**177 °C**
Air pressure at discharge	K-500 No. 9	**6.6 kgf/cm²**	**6.8 kgf/cm²**
Air pressure at discharge	K-500 No. 12	**6.4 kgf/cm²**	**6.5 kgf/cm²**
Oil pressure in the main line after the filter	K-500 No. 9	**5.4 kgf/cm²**	**5.6 kgf/cm²**
Oil pressure in the main line after the filter	K-500 No. 12	**5.2 kgf/cm²**	**5.3 kgf/cm²**

Measurements taken with the units' standard instruments at unchanged output, rotor current and with the throttle valve fully open.

Conclusions of the plant commissions

The commissions of both tests recorded the same thing. At identical operating modes the power drawn by the electric motor decreased under load by **2.8 %** and **3.1 %**, and in idle running by **5.4 %** and **5.8 %**; the reports explain this by "the reduced friction coefficient of the metal-ceramic layer formed in the journal bearings and on the teeth of the gearbox gearing". On machine No. 9 the vibration displacement of the gearbox support where a developing defect had been recorded before treatment decreased **12×**, and no preventive inspection or repair of the gearbox was performed during this period. On machine No. 12, where the mechanical wear of the teeth had initially been beyond the limit, the vibration of the gearbox supports decreased **2-5×**: "the critical wear of the teeth in the gearing has been stopped", and the commission estimates the gain in the residual service life of the gearbox at **1.5×** at the least.

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The results relate to the K-500 turbocompressors of the TsKS-1 compressed-air section at PJSC ArcelorMittal Kryvyi Rih and to the described operating modes; on other equipment and under other operating conditions the figures may differ. The originals of both reports, signed by the commission and sealed by the plant, are published in full and available for download.