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Revision Memo

12/02	Increased run length and time between overhauls for aeroderivative type gas turbines. Referenced Corporate KPI website as alternative maintenance cost data source. Added reference to RAM Analysis for sparing requirements.
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SCOPE

This subsection presents background information related to the serviceability of compressors and their drivers to aid designers in deciding which type to select, how many individual units to apply, and what sparing is needed. This information is also useful in assessing the impact of machinery characteristics on process run lengths and turnaround cycle planning.

REFERENCES

Krystow, P.E., and Reilly, F.P., Spare Parts Procedures and Control, EE Report No. EE.2ER.70

Exxon Project Contracting Manual (Section 8 - Coordination Procedure)

▶ Maintenance Practices Manual, ExxonMobil Research and Engineering Manual, TMEE0062, Section 5-5-3

GENERAL CHARACTERISTICS OF ENGINEERED HEAVY DUTY MACHINERY

GENERAL

Major compression machinery applied in petroleum and chemical process plants differs significantly from the commercial, industrial, and utility classes of machinery that are applied elsewhere. The differences affect cost, delivery times, reliability, versatility and economic life expectancy, and are therefore of importance to the compression service designer.

HEAVY DUTY CONSTRUCTION

Compressor unit machinery construction is characterized as heavy duty to describe its ability to sustain very long run lengths between shutdowns and overhauls, under severe and fluctuating process and environmental conditions. This capability is achieved in reciprocating compressors and engines by the use of low rotating and reciprocating speeds, low stress levels, positive lubrication of rubbing parts and control of pressure pulsations in gas piping. It is achieved in dynamic machinery by fine rotor balance, proper selection of internal clearances for all operating temperatures, and reliability provisions in the lubricating oil and shaft sealing systems. Hydrodynamic rather than anti-friction bearings are utilized to achieve long run length capability.

REPAIRABILITY

A second important characteristic typical of heavy duty design is the convenient renewability of all wearing and commonly damaged parts. Whereas it is usually more economic to replace than to overhaul light duty machines, heavy duty machines are designed to be overhauled in place. The need to replace structural frame and pressure casing parts of heavy duty machines is rare.

PERFORMANCE MODIFICATION

The design features which allow convenient renewability of wearing and damaged parts also tend to allow convenient performance modifications in engineered heavy duty machinery by major component changeout or modification. Steam nozzles can be added or removed in steam turbines; impellers can be trimmed, replaced, or shifted in centrifugal compressors; cylinders can be replaced in reciprocating compressors. This performance flexibility potential allows the high initial investment in frame, casing, and installation facilities to remain productive during the long economic life of a process unit.

The degree to which a machine can be uprated generally depends upon how its original rating compares with the maximum rating for the frame, casing, or model. The uprating flexibility can range from none to extensive, but is generally not revealed by the manufacturer unless the ultimate rating has been recognized in the sales pricing.

TAILORED VERSUS STANDARD UNITS

In compressor unit machinery types, a major distinction exists between machines tailored for unique conditions and those selected as standard pre-engineered models. Major compressors and gear units are almost always tailored for the optimum operating conditions of the service using individually engineered assemblies of standard pre-designed components. Mechanical drive steam turbines are similarly designed, but combustion gas turbines are selected as standard fixed rating models. Small gas and diesel engines are marketed as standard unit designs; large reciprocating engines vary the number of cylinders and sometimes the stroke length to match rating requirements. Power generation steam turbines in most sizes are marketed as standard units with fixed ratings. Centrifugal process compressors are normally customized assemblies of pre-engineered components, whereas centrifugal plant air compressors are marketed as standard rating packages. Large electric motors may be either standardized design or one-of-a-kind design, depending on the vendor and the size.



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GENERAL CHARACTERISTICS OF ENGINEERED HEAVY DUTY MACHINERY (CONT)

A characteristic of individually engineered process machines is that they have a higher potential for design error than do standardized machine models. The risk of vendor design error is minimized by holding extrapolations of the vendor's design experience to a bare minimum and by careful appraisal of the machine design details during the detailed engineering phase.

OPERATING FLEXIBILITY

Engineered heavy duty machinery is normally capable of greater operating flexibility and more process abuse than standardized types of machinery which have been highly developed for specific and well defined applications. Mechanical drive steam turbines designed for variable speed provide a good example of this, when contrasted with power generation turbines, which are designed for extended operation only at the constant synchronous speed. Process refrigeration centrifugal compressors tend to have greater flexibility for off-design operation than do commercial packaged refrigeration system centrifugal compressors. The increased flexibility and ruggedness results because engineered heavy duty machinery is designed with versatility and resistance to abuse as important design objectives, whereas the development of commercial machinery models favors minimum manufacturing cost and maximum performance at the rated point.

LONG DELIVERY TIME

Heavy duty machinery for specific applications is engineered and manufactured following receipt of an order; therefore, delivery times are long. Standardized heavy duty machinery can be obtained on somewhat shorter delivery, but the high cost level normally forces manufacturers to wait for purchase orders before beginning to purchase materials for manufacture.

RUN LENGTH AND TIME-BETWEEN-OVERHAUL CAPABILITY

The various types of compressors and drivers have differing capabilities for the lengths of uninterrupted runs and running time between overhaul maintenance. The following table summarizes run time values for each of the more commonly used machine types. These values apply to the time period following the first year of operation since an abnormal number of inspections and major and minor repairs are typically required during the first year. These values generally require favorable operating conditions but are realistic targets and have been exceeded in a number of instances.

