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Revision Memo

12/01 Added VFD comment to special situations.



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SCOPE

This section presents comparative information on various types of compressor drivers commercially available and the basis for driver type selection. Details on various driver types and construction styles and on mechanical design features are presented in [Sections XI-L, XI-M, and XI-N](#).

REFERENCES

GLOBAL PRACTICE

GP 10-11-1 Sizing of Drivers and Transmissions for Compressors, Fans, and Pumps

OTHER REFERENCES

Gibbs, C. W., *Compressed Air and Gas Data*, Ingersoll-Rand Company, 1969.

Ludwig, E. E., *Applied Process Design for Chemical and Petrochemical Plants*, Volume III, Gulf Publishing Company, 1965.

BACKGROUND

Selection of the optimum type of driver for a compressor unit involves a qualitative screening of the circumstances surrounding the overall plant design, followed by an economic evaluation of the most likely choices. Driver type selection is sometimes so obvious as not to require the detailed evaluation study. However, where significant competition exists between rival types, the comparative study and selection must be made early in the process design stage because a great many aspects of the plant utility system design and compression services design are dependent on this decision.

The basic types of drivers used for process plant compressors are classified in [Figure 1](#). The driver classification system most relevant to process plant design is based on the driver's source of energy. With electric motors, energy is supplied via power transmission cable from an electric power distribution network. With combustion engines, liquid or gaseous fuel is supplied to the machine for internal conversion to shaft work via combustion. With expanders, energy is added to a working fluid medium within one discrete unit operation (steam generator, regenerator, nitric acid plant converter, etc.), and extracted via the expander at some convenient location downstream of the energy source.

For a comparison of driver types see [Table 1](#).

BASIC DESIGN CONSIDERATIONS

DRIVER SIZING

Actual Size - Selection of actual driver power rating or "sizing" is performed during detail engineering, following compressor model selection. The basis for driver sizing is specified by **GP 10-11-1**. This basis should also be used to estimate the required driver size during the process design phase, so that the utility supply system can be designed. Per **GP 10-11-1**:

Driver power rating shall be the larger of 1 and 2 below:

1.
$$\frac{\text{Driven Equipment Normal Power Requirement} \times \text{Load Factor}}{\text{Mechanical Efficiency of Separate Power Transmission}}$$
2.
$$\frac{\text{Driven Equipment Power Requirement of Specified Alternate Operating Condition(s)} \times \text{Load Factor}}{\text{Mechanical Efficiency of Separate Power Transmission}}$$

Load factors, specified in **GP 10-11-1**, vary between 1.0 and 1.15. Mechanical efficiency of a gear unit between compressor and driver ranges between 95 and 98.5%, as shown in [Section XI-D](#). When a gear unit is not used (driver and compressor operating at same speed), the transmission efficiency is 100%.

Driven equipment normal operating point is the point at which normal operation is expected and optimum efficiency is desired.

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BASIC DESIGN CONSIDERATIONS (Cont)

Alternate operating points are often controlling in selection of driver size. The specific compressor operating conditions which are likely to characterize the highest driver load operating point are the following:

1. Highest flow rate.
2. Highest pressure ratio.
3. Highest specific heat ratio of the gas mixtures specified.
4. Highest average molecular weight.
5. Highest inlet pressure.
6. Lowest inlet temperature.

The Design Specification should include the estimated driver rating required to handle the operating point with the highest power requirement, including the load factor of **GP 10-11-1**.

Derating - When driver types are used which are pre-designed to fixed nominal ratings (some gas turbine models, standard reciprocating engines, and all but very large electric motors), the compressor capacity rating may be increased to fully utilize the available driver rating, assuming that this can be done at nominal extra equipment cost.

This practice is not followed when the vendor's equipment price increment nullifies the economic advantage. For instance, most gas turbine models are priced on the basis of the driven load power requirement (to be competitive), and the increment for derating the compressor to the full capability of the turbine model is frequently so large as to make derating unattractive.

ECONOMIC CONSIDERATIONS

Driver type selection is always based on economic considerations. The most important factor is the operating cost of the energy supply. The key factors determining the energy cost are the base fuel value, and the overall efficiency at which the available fuel energy is converted to mechanical work.

Other critical factors in the economic evaluation are:

- Number of units required, as dictated by the continuous run length and availability potential of the practical driver choices.
- Cost of downtime for maintenance.
- Investment requirement for both the driver and its utility supply system: equipment prices plus installation costs.
- Cost of maintenance.

Of relatively little influence in driver type selection are:

- Process control requirements, since adequate control systems can be designed for all driver types.
- Operator monitoring requirements, since, with proper instrumentation, the differences are small in comparison to other economic considerations.
- Noise level, since satisfactory attenuation can be engineered at low cost for all types.
- Size, weight and complexity, since the direct economic impact is often small compared to other factors. However, size and weight are important considerations in offshore applications.
- Driven equipment speed, since gearing can be included to perform any speed change necessary.

VERY LARGE DRIVERS

Drivers in the 35,000 to 100,000 hp range are in a special category in that very few process plant applications have ever been made and each potential application requires extensive engineering study.

MACHINERY SPECIALIST consultation is recommended whenever services in this power range are under consideration.

SPECIAL SITUATIONS

Steam turbines can be applied to a variety of inlet/exhaust pressure levels within the plant to balance process steam needs. Optimum matches of individual turbine power requirements to expansion energy availability should be sought.

Gas turbines have been justified for process plant service only when the exhaust heat is utilized to generate steam or can be recovered in a process furnace. Investments and operating credits for the exhaust heat recovery equipment must be included in the overall evaluation.

Starting Drivers - The steam turbines normally employed as starting drivers for gas turbines can be used for continuous power contribution, if designed for continuous operation. The starting turbine rating can be specified for more than the minimum required for starting, if dual drive is the economic way to meet a high driver load requirement.

