Question 5: What are the pros and cons of motor vs. steam turbine drives for hydrotreater and hydrocracker recycle compressors?

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The nature of the hydroprocessing unit is such that a wide range of molecular weights are possible for the recycle gas from nitrogen at start-up to hydrogen with increased light ends during normal operation. While the treat gas requirements are pre-determined, quench gas demands vary during normal operation with varying chemical hydrogen uptakes and emergency situations. A recycle compressor that has the flexibility to operate in such an environment by changing the speed of the driver has an inherent advantage. The choice between motor and turbine drive is decided by the process safety considerations, refinery steam balance, the reliability of the electric power source, and capital and operating costs. Automatic depressuring is a standard design for hydrocrackers.

First, let us look at the turbine drive. Turbines are selected by plants where steam is readily available at reasonable cost. The high speed turbine can be directly coupled to the high speed compressor and can provide the operational flexibility. Turbines can have higher overall system reliability. Turbine drives can offer additional protection during power failure to cool the reactor and to sweep oil out of the high pressure exchangers and charge heater. Backpressure turbines avoid surface condenser and large cooling water load. Initial installation cost may be higher for turbine. Superheated steam is required. Turbines are more maintenance intensive. The steam supply survivability in case of overall refinery power outage should be factored in the selection process.

Now let us look at the alternative of electric motor drive. Motors are selected by steam balance constrained refineries where a reliable electric supply is available at a cheaper cost than steam. Motor efficiency is higher and it needs less maintenance. The initial investment cost may be lower. The electric drives on charge pump and recycle compressor may preferably be supplied from separate reliable power sources. A gear box is required between the motor and the compressor to match the speeds. Motor has a high starting current requirement. Single fixed speed motor with suction throttling is inefficient. A two speed motor as a minimum provides the operating flexibility. A more preferred option is a 60-100% variable speed drive. It provides safer margin away from surge and saves operating cost. It can provide constant torque capabilities thus lowering the acceleration and deceleration effects on mechanical components during transient conditions. It helps to reduce the startup stress on the motor and also allows increased frequency of restarts. Voltage fluctuations in electric supply should be considered in the motor design.

Two types of variable speed motor drives are variable speed hydraulic coupling and variable frequency drive (VFD). The variable speed hydraulic coupling is cheaper compared to VFD, more efficient due to power splitting and occupies less plot space. The complexity, hence, the reliability and the overall system cost should be evaluated while considering a VFD. A VFD over 1500 HP should have a dedicated heat removal system.

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