THE TOTAL SYSTEMS APPROACH OF CENTRIFUGAL & RECIPROCATING PUMPS FOR CO2 PIPELINE AND INJECTION SERVICES

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INTRODUCTION

Because of the complexities of pumping dense phase CO2, it is recommended that one supplier provide all components. These should be completely skid mounted with pump, driver and accessories, valves, headers and controls all preassembled, wired and tested.

FLOW DESCRIPTION

The attached P&ID represents the latest in state of the art CO2 pumping system technology.

It incorporates many features which provide:

a. ease of control.

b. less energy consumption.

c. less seal oil consumption.

d. longer seal life.

e. remote unattended operation.

Attached please find drawing no. PD-7956-01, P&I Diagram.

Referring to the attached drawing -

COOLER

Flow enters the ethylene glycol cooler which is an 8" ASME heat exchanger with the cooling media being the Liquid CO2 pipeline itself.

In researching other installations, it was found that the seal oil temperature going from the seal console system into the seals was 120-135 deg. F. Using an air to oil type cooler with 110-120 deg. ambient and an approach temperature of 10 deg. led to this minimum cooling temperature. Our objective was to utilize the Liquid CO2 at 60-70 deg. as a heat sink. A total system heat rejection rate of 140,000 BTU/hr. was removed in the CO2 stream and raised the temperature only 1 deg. F.

PUMP

From the heat exchanger, the flow enters the suction of the multistage CO2 centrifugal pump. This could also be a reciprocating positive displacement pump depending on flow and pressures.

PUMP SEALS

The type of mechanical seals utilized in the majority of installations are double seals. A double seal provides very good operation for high suction pressures where the pumpage should not be contaminated by the hydraulic fluid, and where the liquid pumped is non-lubricating and subject to high heat loads.

The horsepower generated by the seal pressure loading of each of these seals is approximately 15 HP each. The heat rejection rate will be approximately 80,000 BTU/hr. Since these seals are expensive and time consuming to change, it is important to have a seal system which will provide adequate pressure, adequate flow, adequate temperature cooling, and steady state operation.

PRESSURE TRANSDUCERS

Control of the system is maintained by the pressure transducer on the suction end and the discharge of the pump. The pressure transducer on the suction provides a signal into the PLC. This controller then maintains the seal injection pressure at a 50 psi differential above suction pressure.

Conventional systems use a pressure switch. An example would be as follows - if the pipeline design suction pressure is 1900 psig, a 50 psi Delta or increase would be provided by the seal system to the seals. If the suction pressure falls to 1600 psig, the seal flush injection system would be set at a constant 1950 psig leaving a Delta of 350. The system shown on the attached drawing is controlled off of the suction pressure transducer and maintains a constant 50 psi Delta above the suction pressure as it varies. This decreases the consumption of seal oil.

The pressure transducer on the discharge of the pump controls the speed of the multistage injection pump motor. It does so in accordance with a set discharge pressure programmed into the PLC.

As injection wells are shut in and discharge pressure increases, the motor will slow basis reduced frequency from the VFD. Flow would be decreased thereby matching the set point pressure.

VALVES

Fail closed valves are provided on the suction, vent line, and discharge line. Due to various start-up and shutdown conditions, these valves will automatically modulate to shut the pump in on a system failure or go through an automatic manual start-up sequence.

SEAL OIL CONSOLE

The attached seal system is a current design. It is a high pressure closed loop system. The seal flush is circulated by a special high pressure seal oil circulating pump which is designed to accommodate the inlet pressure of 1950 psig. This pump boosts the circulation rate by 50 psi and circulates seal oil through the seals, back to the seal oil cooler and through the filters.

A seal oil pressure maintenance/intensifier pump is provided. This pump will cycle on and off with a signal from the PLC which will maintain the set pressure of 50 psig above suction pressure.

SEAL OIL RESERVOIR

A seal oil reservoir is included in the floor of the system which will eliminate the requirement for outside tankage, piping and controls.

ETHYLENE GLYCOL COOLING SYSTEM

A low pressure ethylene glycol coolant circulating system is provided to minimize high pressure piping and maintain adequate cooling. This system circulates cooling ethylene glycol from the main line CO2 cooler to the seal oil cooler, pump bearing housing, and mechanical seals. (Option to heat exchanger for VFD.)

VFD AND CONTROL PANEL

A pulse with modulated or current source inverter is included to modulate the speed of the main CO2 injection pump. VFD's according to the manufacturer can be provided without cooling or with cooling, and this will be done either by air conditioning the control room or with a heat exchanger from the glycol cooling system.

As a standard, line reactors are included to avoid any voltage dips or spikes due to typical locations of equipment at pipeline or production locations. Standard construction includes two contactors - one for running the main motor off the VFD; and if problems occur with the VFD, the motor can be run directly across the line and flow modulated by the 3" globe bypass valve. This would be for temporary operation.

The control panel includes a PLC with PID loop capabilities. Software which is utilized to control the PLC is written to provide automated start-up, all shutdown operations, opening and closing of valves, scrolling of all shutdown or alarm conditions, and even interface with a remote PC if required.

SUMMARY

In summary, this complete system was provided on a large wide flange skid with all the pump drivers, accessories, piping, valves, and

controls assembled and tested. A building was erected on the skid in the assembly shop, and the complete unit was shipped to the field.

Slides will be shown of this installation both before shipment and after shipment.

In conclusion, with a system approach, the end user can be assured of:

a. specified performance.

b. a complete analysis of the CO2 stream to maintain correct performance.

c. correct selection of pumping equipment.

d. correct selection of sealing arrangement.

e. correct selection of auxiliary equipment such as seal consoles, cooling, other accessories.

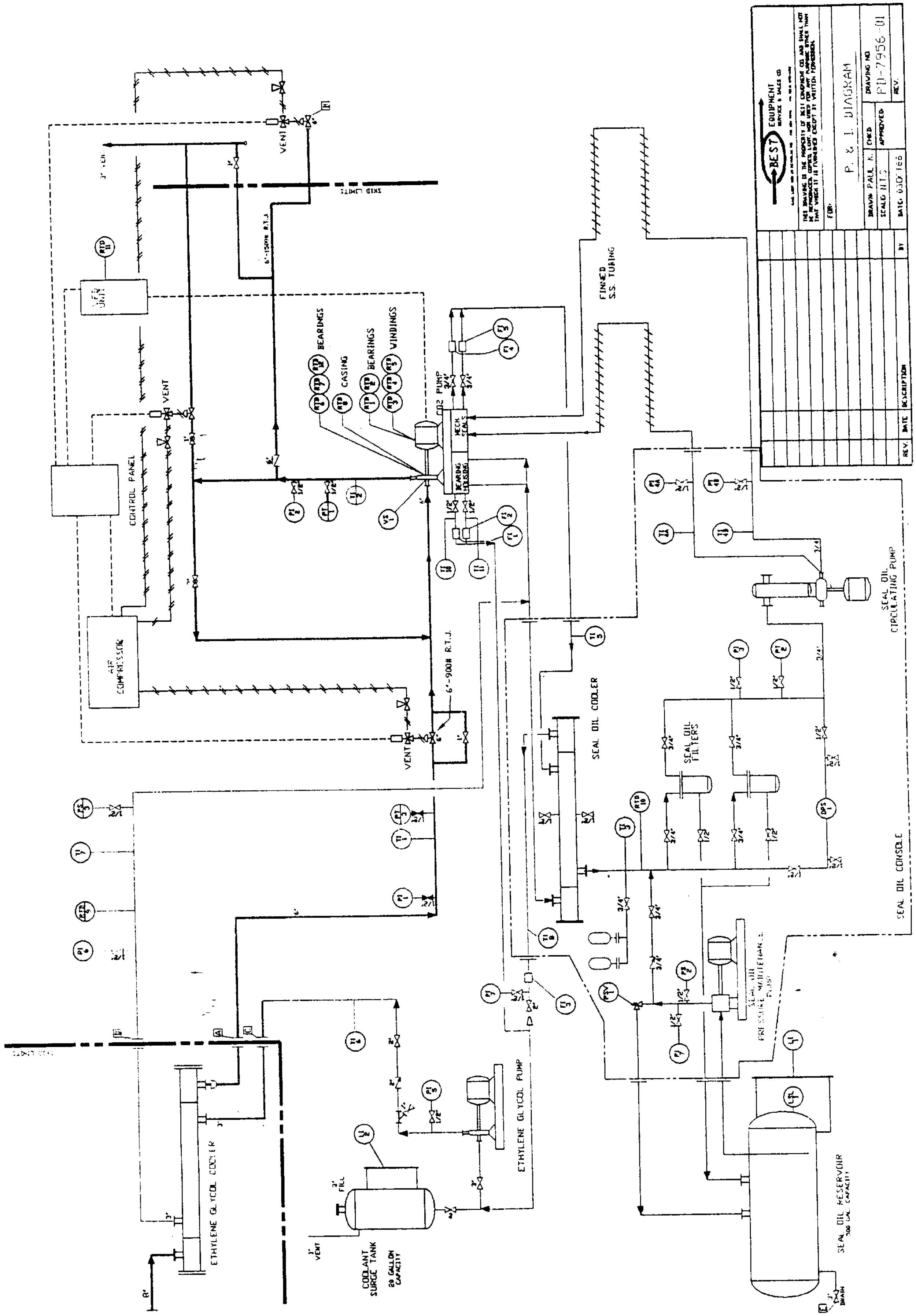
f. drive selection in accordance with horsepower, torque, cooling and other parameters.

g. correct controls are utilized and testing can be done on the system as a whole.

h. field labor installation is minimized.

i. unit responsibility is maintained.

j. quality can be maintained by single engineering, manufacturing and service from a unit supplier.


P. & I. DIAGRAM
SEAL OIL CONSOLE
SEAL OIL COOLER
SEAL OIL FILTERS
SEAL OIL CIRCULATING PUMP
SEAL OIL RESERVOIR
ETHYLENE GLYCOL PUMP
ETHYLENE GLYCOL COOLER
COOLANT SURGE TANK
AIR COMPRESSOR
CONTROL PANEL
FINNED S.S. TUBING
BEARINGS
CASING
VENT
SKID LIMITS
6"-900# R.T.J.