CHEMETRON™ Fire Systems

CARDOX

CO_2 Application Bulletin

CHEMETRON™ Fire Systems
A World of Protection

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CARBON DIOXIDE FIRE SUPPRESSION —

Hydrogen Cooled Electric Generators

Inerting/Purging Systems

When the generator rotor is turned at high speed in larger steam turbine units, the turbine must overcome the resistance to the turning rotor created by the atmosphere in the generator casing. This wasted energy use is called windageloss. To reduce this windage loss to a minimum, the air in the casing is replaced with hydrogen, our lightest gas.

When the unit is first installed, the casing is full of air. The air cannot be directly replaced with hydrogen without going through the explosive range (which is quite broad for hydrogen). Similarly, when taking a unit from service, the hydrogen in the unit cannot be directly bled off and replaced with air without again going through the explosive range. To keep from creating an explosive atmosphere, CO_2 is used to inert the air before the hydrogen is introduced into the casing. Then the CO_2/air mixture is replaced by the hydrogen. To empty the casing, the hydrogen is purged by CO_2 and then the unit ventilated when the casing is opened.

The generator manufacturer builds a CO_2 manifold into the bottom of the machine (CO_2 being heavy) and a hydrogen manifold in the top (hydrogen being light). This helps prevent mixing and reduces the amount of gas needed. This gas exchange is normally done on turning gear. More gas is needed if done at speed. (See the diagram on page 4 which illustrates this inerting/ purging operation.)

Purging the hydrogen from the machine is usually estimated to require about two volumes of CO_2. To replace the air before hydrogen is introduced will take 1½ volumes. Thus, it can be estimated that it will take 3½ volumes of CO_2 to take a unit out of service, open the casing, and then return the unit to service. If done at speed, it could take 5 volumes.

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Years ago, it was common practice for the generator manufacturer to provide a CO_2 supply of high pressure cylinders manifolded together. These were not fire system cylinders, but rather cylinders with manual valves at the cylinder vapor spaces. With this arrangement, CO_2 vapor is bled off from the cylinders into a manifold, and then regulated pressure CO_2 introduced into the generator through the controls and manifold provided by the machine manufacturer.

Liquid CO_2 is not used; vapor is withdrawn, which prevents the cooling that occurs when liquid is discharged. As the vapor from the cylinder is bled off, the pressure in the cylinder drops and the flow slows. In the time usually allotted for purging, all the CO_2 in the cylinders cannot be recovered unless external heating is used. It can be assumed that perhaps 70% is recoverable. (If it's hot and you allow enough time, this percentage will increase.)

The disadvantages of the cylinder system are:

1. There is only a minimum amount of CO_2 available. Thus, if a second purge is needed, there could be delays until a replacement CO_2 supply is obtained.

2. The CO_2 flow rate is determined by the vapor bleed off rate, which is a function of how many cylinders are bleeding and the heat input to the cylinders. It is hard to increase the rate if this should ever prove necessary. In an emergency, it may be appropriate to purge the hydrogen as fast as possible.

3. Plant personnel have to handle high pressure gas cylinders, which is always a risk. For this reason, the industry trend is to bulk gas systems. Special rigs for handling cylinders to prevent an accident — where the cylinder becomes a projectile — are common.

4. Cylinder CO_2 is more costly and not as readily available as bulk liquid CO_2.

Except for very small generating units, CO_2 in cylinders is rarely used today. Rather, the bulk low pressure system is favored. With the low pressure CO_2 system, the CO_2 vapor needed is obtained by taking liquid CO_2 from the unit and putting it through a direct to process vaporizer. This adds the heat of vaporization (about 120 BTUs/lb.), plus the additional heat required to get the CO_2 temperature up to the desired level. The CO_2 vapor then goes through a flow control manifold (throttling valve, regulator with gauge) to establish the proper flow rate. CO_2 is usually used at 75 - 90 psi with a purge time of an hour or two. The flow control schemes are normally redundant. When the flow rate is established, it is normally left set at that level, but can be easily increased in an emergency. If a system with remotely actuated operating valves is required, this is easily accomplished. Refer to the drawing of the Carbon Dioxide Purging System, which illustrates an arrangement where the CO_2 main control valve is electrically operated, which allows pushbutton operation. The electric vaporizer is a demand type with thermostatic control; when the valve opens and cold CO_2 liquid is introduced into the vaporizer, the platen heating elements are automatically turned on. Therefore, the unit is always ready to go, but uses no power until heating is needed.

Since the maximum flow rate is a function of the capacity of the vaporizer, the vaporizer is sized to a worst case condition. Increases in vaporizer capacity do not proportionately increase the cost.

The advantages of the low pressure system and the ability to use this same storage unit for multiple purposes (hydrogen purging, coal silo inerting, fixed fire protection, hand hose line coverage, etc.) has made it virtually an industry standard.

More details on specific system arrangement are available from Chemetr on.

Other Inerting Uses

When there is any application for CO_2 vapor, the setup for using the LPCO_2 System and the direct to process vaporizer to give the required quantities of vapor are virtually the same as that described above

for the hydrogen purge. Each pound of CO_2 will expand to about 8.3 cubic feet of vapor at atmospheric conditions. The volume of CO_2 required is calculated and converted to pounds as this is how the vaporizers are rated.

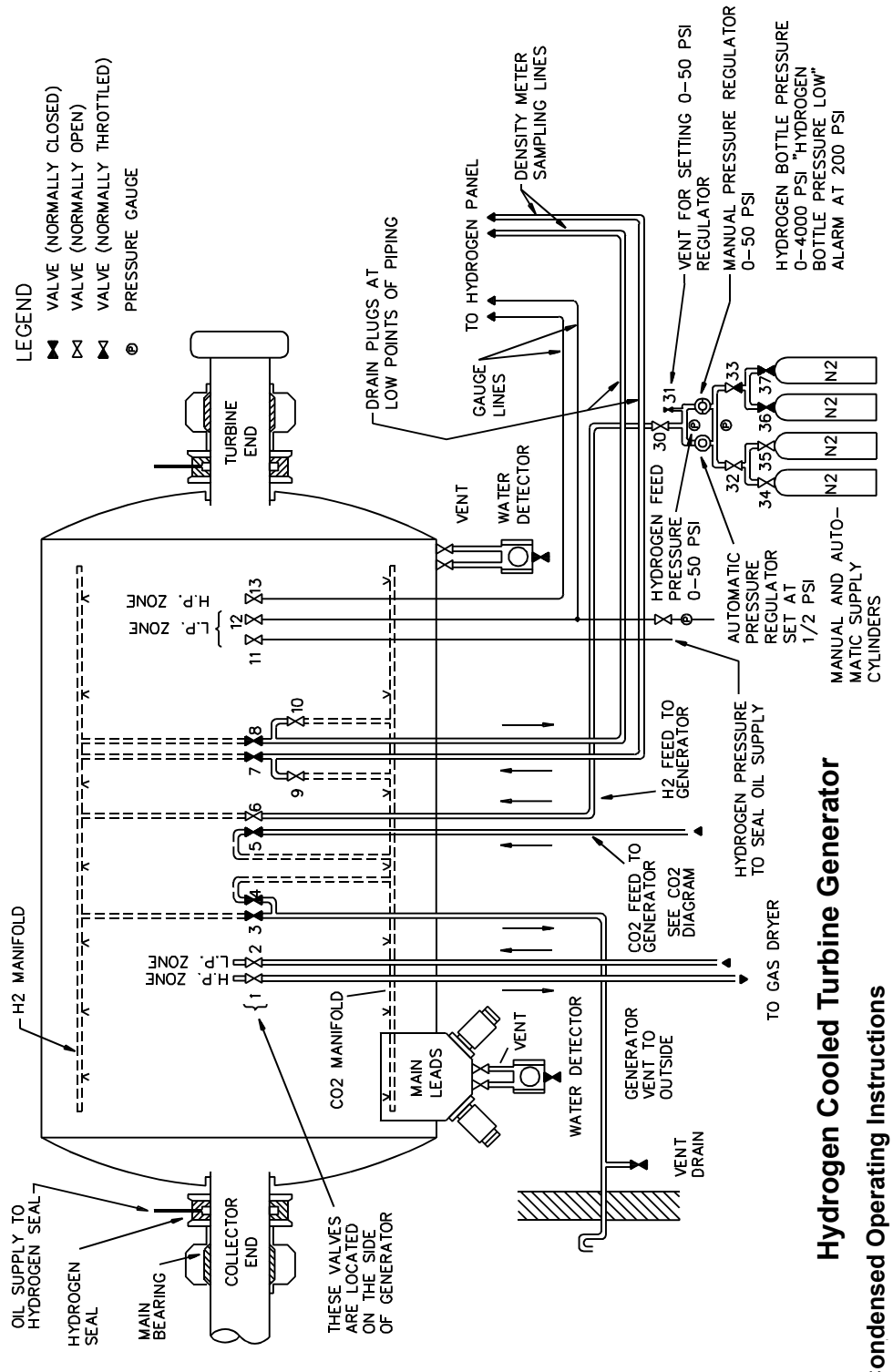
Basic units are:	375 lb./hour	15 KW
	750 lb./hour	38 KW
	1,125 lb./hour	45 KW
	1,500 lb./hour	60 KW

These direct to process vaporizers provide standard features, including a weatherproof enclosure, replaceable pressure cast heater platens, low discharge temperature safety shutoff, and circuit breaker load projection.

If only intermittent use of CO_2 vapor is contemplated, one vaporizer can usually satisfy two uses.

REGULATORY ALERT

WHERE CO_2 IS USED, COPIES OF THE MATERIAL SAFETY DATA SHEETS (MSDS) SHOULD BE OBTAINED FROM THE CO_2 GAS SUPPLIER TO PROVIDE ALL WHO USE THIS PRODUCT WITH A COPY PER OSHA HAZARD COMMUNICATION STANDARD 29 CFR 1910.1200(G).



Hydrogen Cooled Turbine Generator

Condensed Operating Instructions

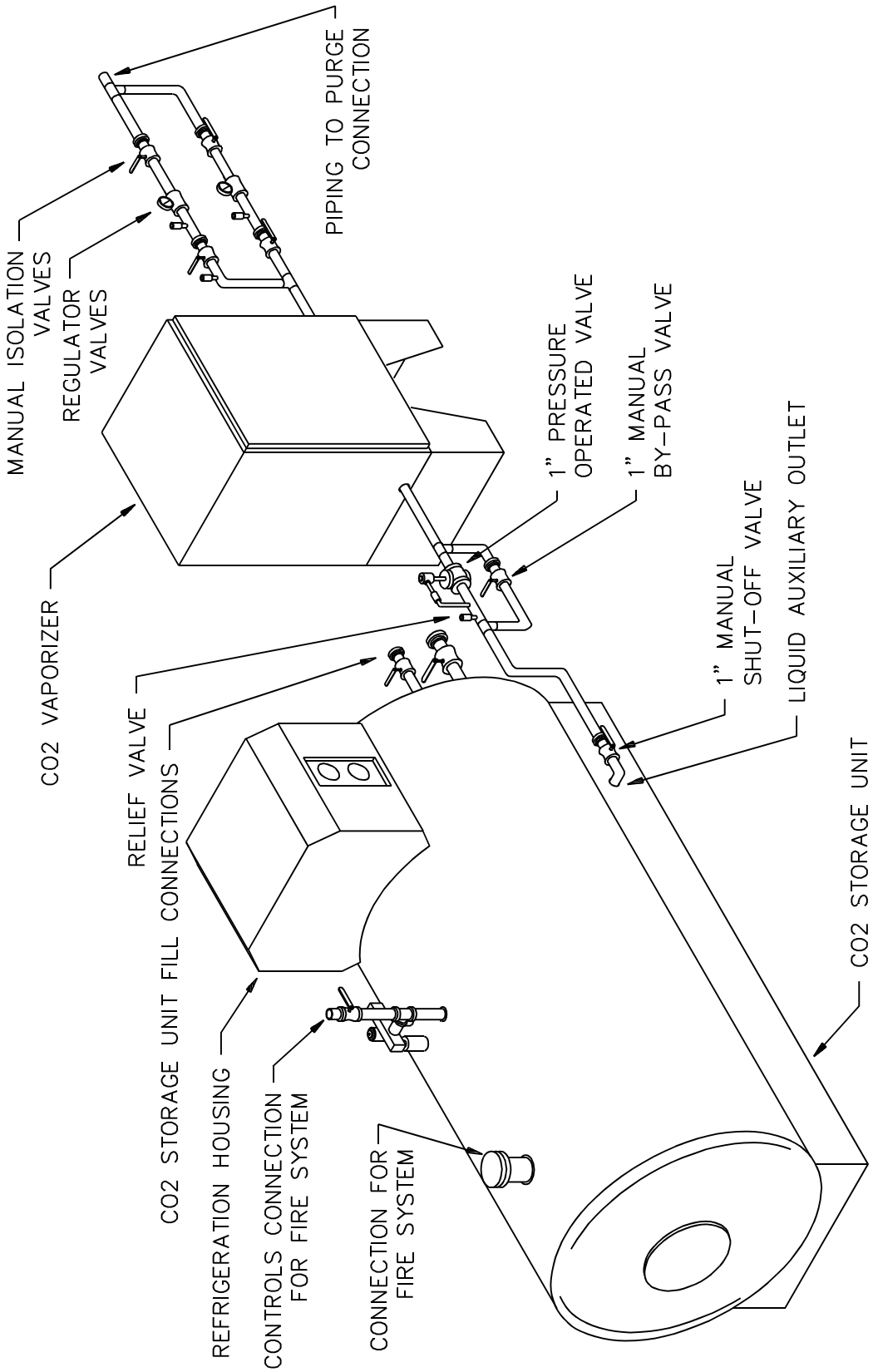
General - The gas changing operations may be performed with the generator at standstill, on the turning gear, or at speed with load limited to 50%. Shaft seal oil pressure must be maintained.

Replacing Air With CO_2 - The normal setting of the valves is indicated on the diagram. Open 7 and 8, close 9 and 10, open 3 and 5. Then admit CO_2. 1-1/2 volumes of CO_2 are required at standstill or on turning gear; 2 volumes of CO_2 are required at speed. When finished, change valves back to normal: close 3 and 5, open 9 and 10, close 7 and 8.

Replacing CO_2 With H_2 - Open 3; open 50 psi regulator. Open 34 and 35; open 32. Bottle pressure should be approximately 2,000 psi. When the bottle pressure drops to 200 psi, close 32 and open 36, 37, and 33, and continue. 2-1/2 volumes of H_2 are required at standstill or on turning gear; 3-1/2 volumes of H_2 are required at speed; standard H_2 bottles contain 190 cu.ft. When finished, close 50 psi regulator and 3; 1/2 psi regulator will main-tain pressure. Operation is then normal as indicated on diagram.

Normal H_2 Operation - 1/2 psi regulator will maintain pressure. The 0 to 50 psi regulator may be used to hold pressure between 1 and 15 psi. When changing bottles, check for leaks by closing the bottle valves and checking the bottle pressure gauge, which should not drop appreciably in 5 minutes.

Replacing H_2 With CO_2 - This operation is the same as replacing air with CO_2, except that 2 volumes of CO_2 are required at standstill or on turning gear, and 3 volumes of CO_2 are required at speed.



Low Pressure CO_2 Purging System for Hydrogen Cooled Electric Generator

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