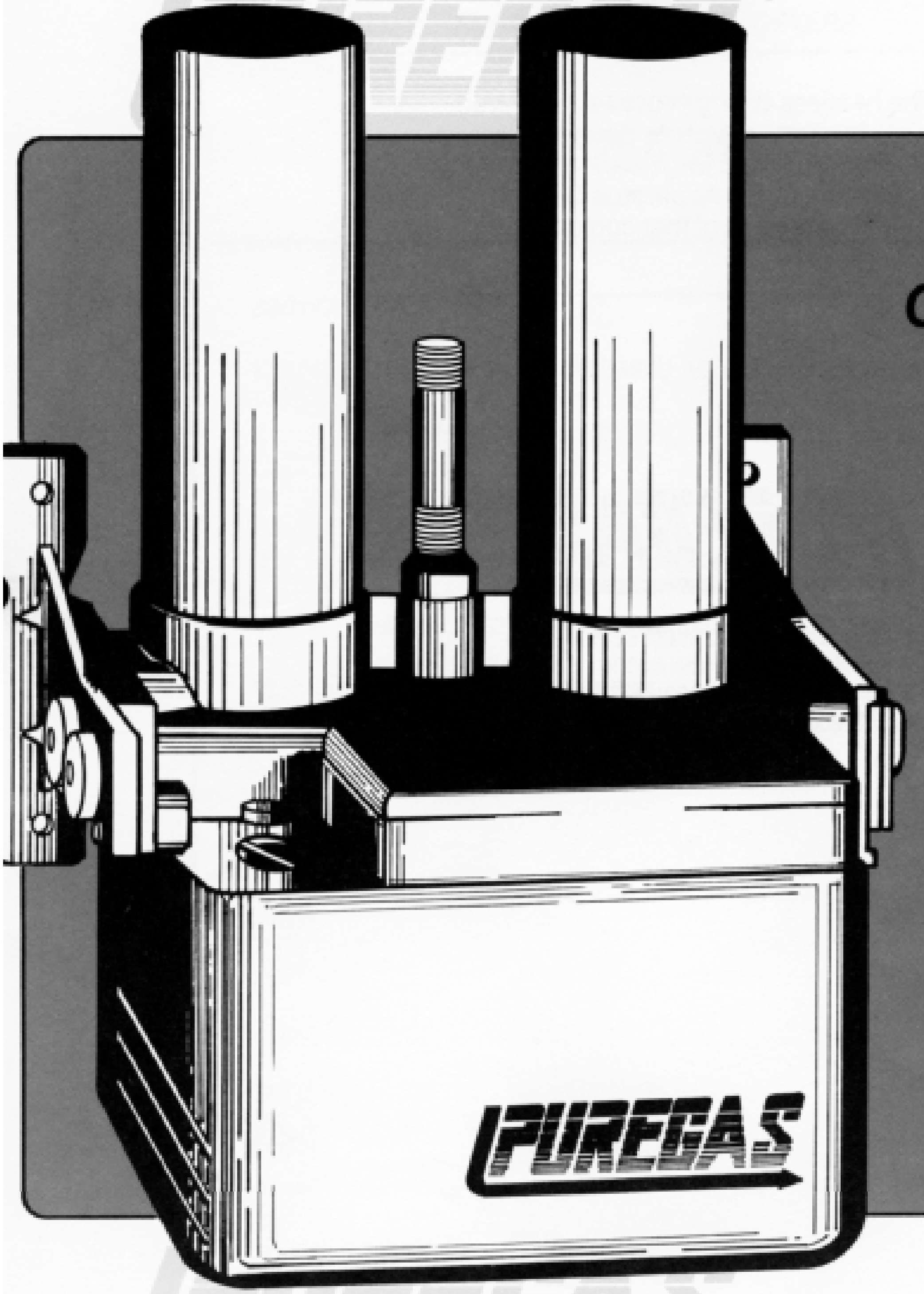

DRYING COMPRESSED AIR AND OTHER GASES with PUREGAS® HEATLESS DRYERS

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by several patents issued to
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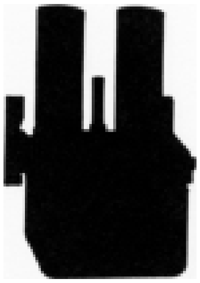
DRYING COMPRESSED AIR AND OTHER GASES
with
PUREGAS HEATLESS DRYERS

TABLE OF CONTENTS



section I

Moisture in Compressed Air and Other Gases

1. GENERAL

ough this discussion refers exclusively to air, it lies generally to all of the atmospheric gases vidually (oxygen, nitrogen, argon, neon, etc.), and t other common gases as well. The discussion deals compressed air insofar as its moisture content and removal thereof are concerned. It does not purport e a complete treatise on the subject of the properties ir and the principles of air compression.

r basic factors are involved in dealing with pressed air. They are:

1. Pressure
2. Temperature
3. Volume
4. Humidity (moisture content)

four of these factors are inter-related, so that any nge in one tends to cause a change in all of the rs. The moisture content of air, or the amount of er that air can “hold” in vapor form, varies with the er three factors. Its moisture holding capacity is ced when the volume is reduced as the result of an ease in pressure, provided that the temperature ains unchanged. However, when air is compressed, emperature rises, which in turn increases its moisture ing capacity.

en air is compressed to 100 PSIG (pounds per square , gauge), its volume is reduced by a factor of nearly 8 . Its capacity to hold moisture is reduced similarly. s, if the air were saturated, or nearly so, before pression, after compression a large portion of its sture would condense (revert to liquid form).

ever, this condensation does not take place inside compressor because compression is always ompanied by a rise in temperature, which is more sufficient to retain all of the moisture originally tained.

increased temperature of the air caused by pression may be 300° F or higher. This high temperature is not desirable for most compressed air uses, and it would be difficult to maintain in the compressed air line if it were desirable. The temperature of the compressed air starts to drop as it leaves the compressor. Most compressed air systems include a storage tank or “receiver” immediately downstream of the compressor. A substantial drop in temperature usually occurs in the receiver, and in many installations heat exchangers (aftercoolers) are installed in the line between the compressor and the receiver for the express purpose of reducing the temperature of the air to near normal. As the temperature of the air falls, its moisture holding capacity is reduced, and condensation takes place.

2. CONDENSATE REMOVAL

Many compressors, especially the larger ones, are oil lubricated and it is virtually impossible to prevent some carry-over of the lubricating oil into the air stream without filtration. As a rule, the older the compressor, the greater is the amount of oil carry over. Even if it were possible to prevent carry over of liquid oil entirely, some oil would be retained by the air in vapor form, as all lubricating oils are volatile to some extent at the high temperatures of compression. While a substantial portion of oil carry-over and condensed moisture is usually retained in the receiver, further temperature drop in the line downstream causes further condensation.

In a proper installation, a drain connection is provided in the bottom of the receiver for releasing oil and moisture condensed in the aftercooler and the receiver. If an automatic condensate release device is provided, or if the manual drain is properly maintained, virtually all of the oil and moisture condensed as the result of further cooling downstream need be contended with, buteven this, in virtually all uses of compressed air, would bc most undesirable. For this reason, it is almost always desirable to install some form of condensate trap or separator immediately ahead of any point of use. The separator may be in the form of a filter, which will not only collect condensed droplets of oil and water, but dirt, rust and scale that may have accumulated in the pipe as well. Or it may be in the form of a simple "drip leg" with a drain cock at the bottom.

While it is true that removal of oil and moisture condensate is sufficient "drying" for a small percentage of compressed air uses, further drying is necessary or at least desirable in the majority of cases. It is for this purpose, removing a part or most of the moisture vapor in compressed air, that the Puregas Heatless Dryer is used.

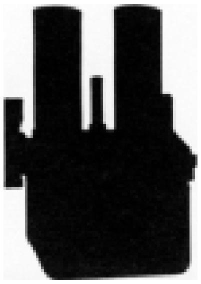
3. COMPRESSED AIR DRYING

Removal of oil and water that has condensed from a stream of compressed air upon its return to normal temperatures actually is a form of drying, and condensate separators, traps and filters are sometimes referred to as dryers. However, for the purpose of this discussion, we will refer to "drying" and "dryers" only in connection with the removal of part or most of the water remaining in the air in vapor form after all of the liquid droplets or mist has been removed. The desirability of further drying beyond the point of liquid oil and water removal is frequently overlooked by users of compressed air, either because they are not familiar with the benefits to be derived therefrom, or because they are not aware of the fact that further moisture removal is a relatively simple matter. There are two basic reasons for reducing the moisture content of compressed air below the saturation point. First, there are those instances wherein the air line may be exposed to lower temperatures, which would cause further condensation. It is especially important to prevent such condensation from taking place in an ambient temperature which is below freezing, as the moisture congeals immediately upon condensation and eventually may cause a complete stoppage of the air flow. Second, there are many cases wherein an appreciable amount of water vapor in air is very undesirable, either from the standpoint of the corrosive action of high humidity air, or because the moisture has an undesirable effect on a process or instrument in which it is used, or with which it comes into contact. In some instances it is necessary to reduce the moisture content of air to a very small fraction of its moisture holding capacity.

4. RELATIVE HUMIDITY AND DEWPOINT

When air is saturated with water vapor, it is said to have a "relative humidity" of 100%. If it contains only one-half as much moisture as it could hold at saturation, its relative humidity is said to be 50%, etc. The relative humidity of air is only an indirect indication of the actual amount of moisture, because the temperature at which the relative humidity is determined is an important factor. For instance, air that is saturated at 50° F contains 1.2% moisture by volume, while at 70" F saturated, the actual moisture content is 2.4% by volume. In each case, the relative humidity is said to be 100%, but the air at 70° F contains twice as much actual water as that at 50° F. Thus, if the temperature of the colder air were raised from 50° F to 70° F without a change of pressure, its relative humidity would be reduced from 100% to 50%. The actual amount of moisture contained in saturated air at various temperatures has been determined experimentally. Tables containing this information are available. They are sometimes referred to as Psychometric Tables. Such a table is included in the Appendix to this Manual.

The "dcwpoint" of air is defined as that temperature at which water vapor in the air starts to condense or change to water. The dcwpoint of air which is saturated at 70° F is 70° F. Air at 70° F and 50% relative humidity will start to condense moisture if cooled to 50°F. Its dcwpoint is 50° F. When dewpoint temperatures below 32 F are encountered, they are sometimes referred to as frost points. Dewpoint temperatures are usually referred to atmospheric pressure, unless otherwise stated. The dewpoint of air with a given actual moisture content varies with its pressure. The higher the pressure, the higher the dcwpoint. A Dcwpoint Conversion Table is included in the Appendix. When the dcwpoint of air is at atmospheric pressure, or any pressure is known, its dewpoint at any other pressure may be determined (within the limits of the table).



section II

Applications

1. GENERAL

Compressed air is used almost universally throughout industry. With practically no exceptions, failure to remove moisture from the compressed air results in extra costs, either directly or indirectly. These extra costs result from product loss, production time loss, rapid tool deterioration and added operating and maintenance costs, which in turn are caused by the effects of moisture in the air on the piping, instruments, products and machinery with which it comes into contact. In some compressed air systems, no provision is made for moisture removal, and the effects thereof are almost certain to result in substantial added costs.

In other systems, provision is made for the removal of condensed moisture only. While this may suffice for a minute portion of compressed air uses, an unexpected drop in temperature in the surrounding atmosphere could result in further condensation, which would then have to be contended with.

In still other systems, partial drying may be provided in the form of deliquescent or refrigerative drying, which may be totally inadequate for certain uses.

In any of the above cited cases wherein only partial moisture removal or none at all is provided, Puregas Dryers can be used to advantage to save costs by merely preventing condensation in the system or by providing ultra-dry air for critical uses at selected points. Puregas Dryers are also used to remove moisture from compressed gases other than air. These include, without exception, the common, inert gases (nitrogen, argon, neon, helium and carbon dioxide). Puregas Dryers may also be used to remove moisture from other common gases, but with certain restrictions. They include oxygen, which requires a completely oil-free system, and hydrogen, which, being explosive, should be handled in explosion-proof equipment. Many other gases, including flammables, such as natural gas, may also be dried. However, if the gas contains significant quantities of sulfurous compounds or other highly corrosive contaminants, corrosion may result in reduced dryer life.

2. SPECIFIC APPLICATIONS

A. INSTRUMENT PURGING

1. Analytical Instruments
2. Indicating and Recording Instruments
3. Computers

Examples: The optics compartments of "single-beam" Infrared Spectrophotometers, such as those manufactured by Beckman Instruments, Inc., Perkin-Elmer, Digilab, Nicolet Instruments and Mattson Instruments require dry gas purge to eliminate read-out interference.

IBM Computers (not all models) require dry air purge.

B. PNEUMATIC INSTRUMENTATION AND CONTROLS

1. Heating and Air Conditioning
2. Gas Turbines
3. Process Controls used in the manufacture of foods, drugs, chemicals, machinery, etc.

Examples: Pneumatic Controls such as those made by Honeywell, Inc., Johnson Service Co., Powers Regulator Co., Robcrtshaw and Barbcr-Coleman, all require dry air.

Pneumatic Controls used on Gas Turbines such as those manufactured by General Electric Co., Westinghouse Electric Corp. and others require dry air.

Pneumatic Controls for controlling pressure, temperature, flow, etc. in all sorts of manufacturing processes require dry air.

A large and very complicated machine tool manufactured by a Machine & Tool Company in New England uses an automatic template tracer which is controlled by a continuous electric arc, which, in turn, requires a dry gas atmosphere.

C. PURGING CONTROLLED ATMOSPHERE CHAMBERS

1. Dry Boxes (Glove Boxes)
2. Environmental Chambers (Experimental, Electronic Circuit Stress, Aging, etc.)
3. Vacuum Systems

Example: Many intergrated circuit transistors and other small electronic parts are manufactured in controlled atmosphere chambers, of which dryness is usually an important factor.

D. PNEUMATICALLY OPERATED MACHINES

1. Air Cylinders
2. Air Motors
3. Air Gauges
4. Air Bearings

Example: The Dentist's drill is a very common example of a machine operated by an air motor, which will not tolerate excessive moisture.

E. DRY GAS BLANKETING OF STORED MATERIAL AND PACKAGING OPERATIONS

1. Food
2. Drugs
3. Chemicals

Example: Dry gas blanketing of aspirin tablet packaging (bottling) operation is employed by a manufacturer of aspirin in Tennessee.

F. DRY GAS REFERENCE FOR MOISTURE MEASURING INSTRUMENTS

Example: A well known instrument manufacturer produces a Moisture Analyzer which measures moisture content of gases to concentrations of 1/2 PPM or lower. A Puregas Heatless Dryer is used to provide a dry gas reference.

G. DRY AIR PRESSURIZATION OF POWER AND COMMUNICATION CABLES AND WAVE GUIDES

H. PAINT SPRAYING (INCLUDING EPOXY AND PLASTIC COATINGS AND MOLTEN METALS).

Examples: Where especially good finishes are required, moisture in the carrier air used cannot be tolerated.

In spraying molten metals, moisture in the carrier air causes “flame-out” and spotty coatings.

Certain plastic coatings are applied in powder form electrostatically and the plastic powder must be “fluidized” using dry gas.

I. OZONE GENERATION

Example: Many well known manufacturers of Ozone Generators that produce concentrations of 1% to 6% by weight specifies feed air or oxygen with a maximum moisture content of 100 PPM or less.

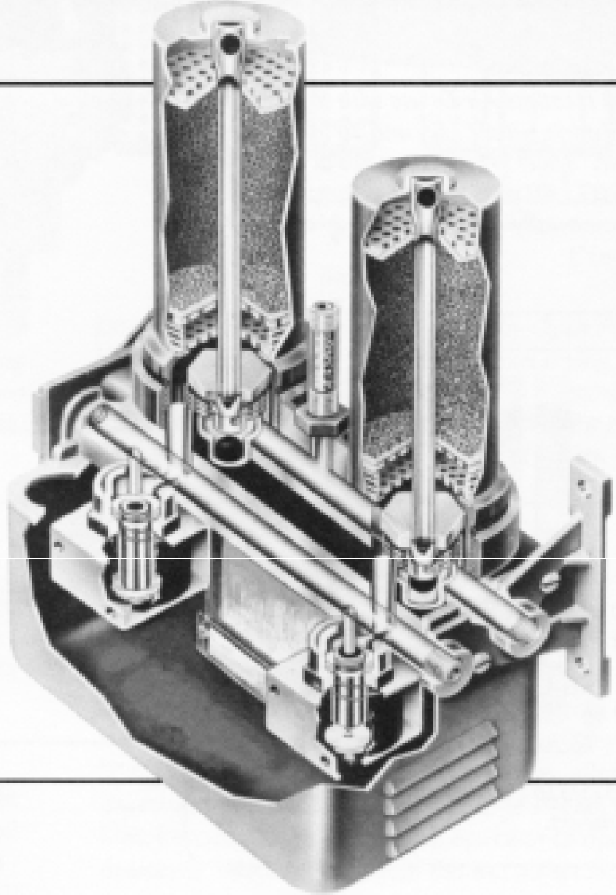
J. FLUIDIZING SOLIDS

1. Chemical Reactions
2. Transport (Pipe Line)
3. Electrostatic Coating

Example: See “H” above.

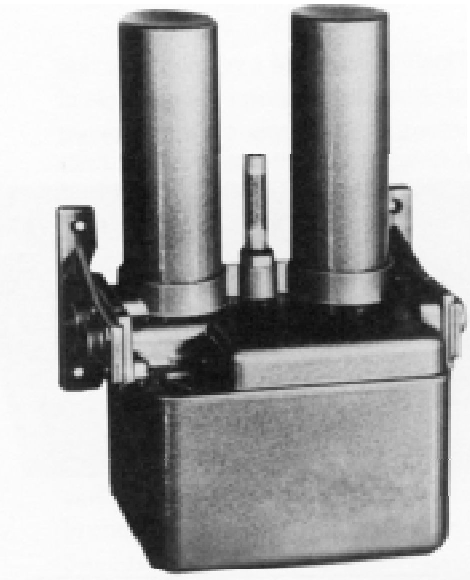
section III

The Puregas Heatless Dryer

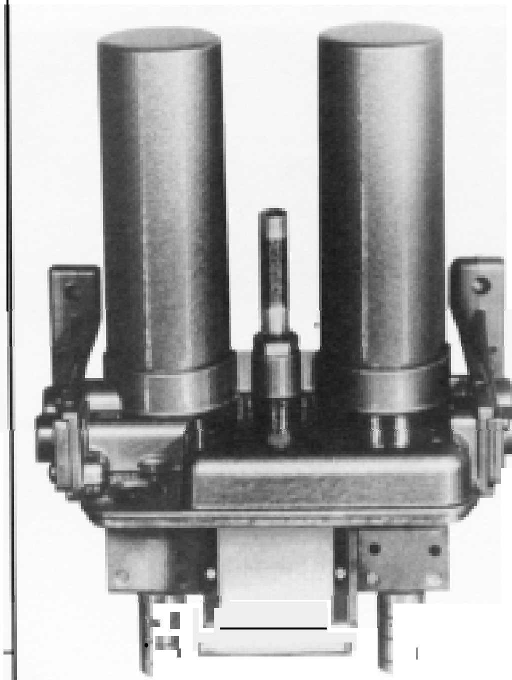


1. DESCRIPTION

The Puregas Heatless Dryer is a device for removing water vapor from compressed air and other gases continuously and automatically. It is compact and light in weight, and may be installed directly in the line. All models are designed for wall mounting. The Dryer consists primarily of two cylindrical chambers packed solidly with desiccant, a material which has a powerful affinity for water vapor. The air stream being dried passes alternately first through one chamber, then the other. While the main air stream is passing through one chamber, the other chamber is being purged of previously accumulated moisture (“reactivated” or “regenerated”). Change-over from one chamber to the other is accomplished automatically on a timed cycle by means of two DC solenoid valves controlled by a DC solid state cycle timer. The term “Heatless” is used to distinguish this Dryer from those of earlier design which require the application of heat from an external source to accomplish reactivation.



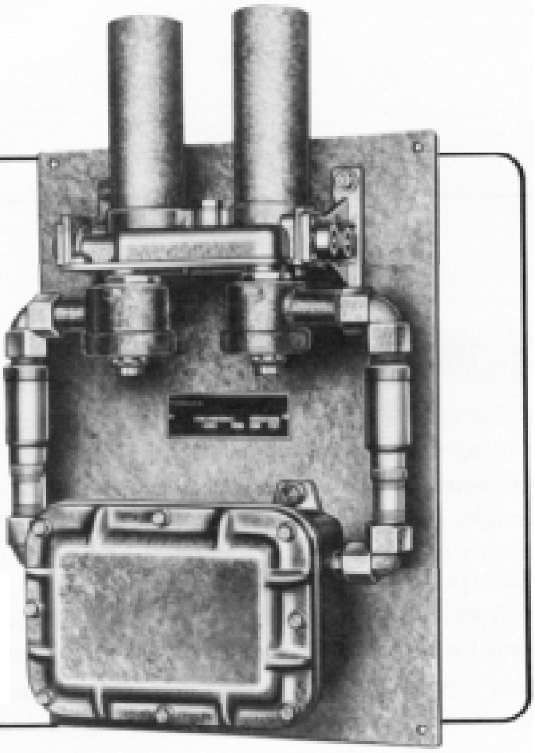
Series HF200 Heatless Air Dryers with 6' desiccant chambers. Models with 9", 12" and 20" chambers are also available. Series HF300 operates at pressures up to 150 PSIG. All models can be furnished with valves either normally open or normally closed. (See Specifications)



Optional Moisture Indicator. Available on all models. Blue crystals turn pink if instrument delivers wet air for any reason such as malfunction or overload.

***Purge** Muflers. Supplied standard on I00-301,303, CDA2 and CDA 1 CO2 Absorbers. This option is available on all models.*

HF315/316 Parallel Air Dryers with 20" chambers.



Series HF203 Explosion-proof Heatless Air Dryer with 6" chambers. Models with 9", 12" and 20" chambers are also manufactured. Operates at pressures up to 100 PSIG; 150 PSIG with normally open valves.

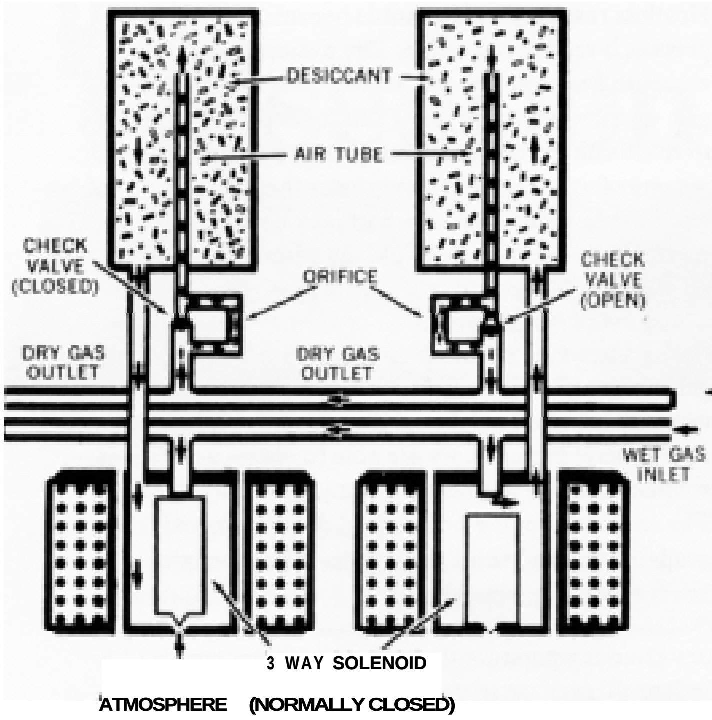


Diagram of air flow through a Normally-Closed Puregas Heatless Air Drver. Right chamber shown drying, left being reactivated or purged. Direction of airflow through the two chambers is alternated every thirty seconds by a solid state cycle timer controlling two D C solenoid valves

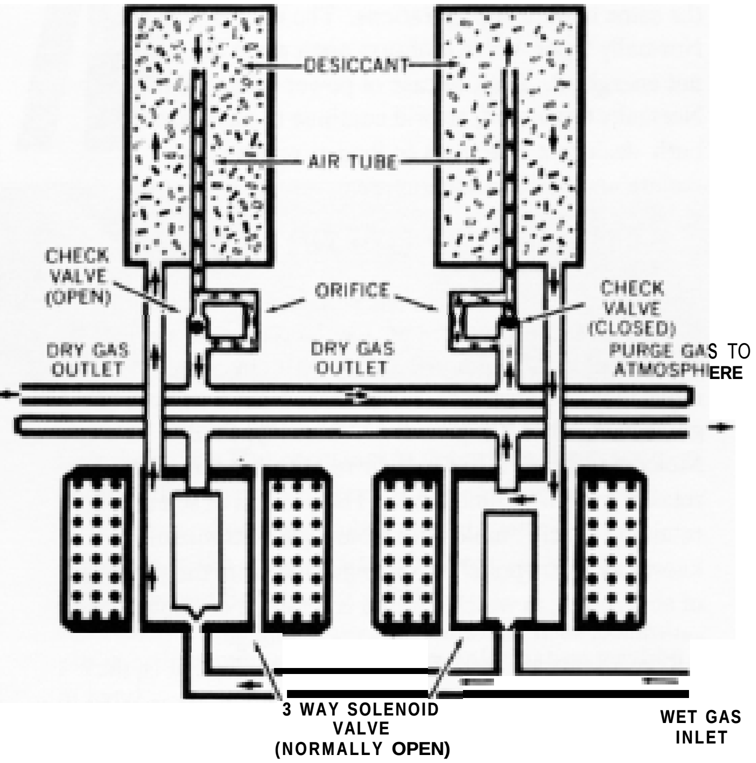


Diagram of air flow through a Normally-Open Puregas Heatless Air Dryer Left chamber shown drying, right being reactivated or purged. Direction of air flow through the two chamber is alternated every thirty seconds by a solid state cycle timer controlling two D C solenoid valves.

2. HOW THE DRYER OPERATES

In this Dryer the desiccant chambers and solenoid valves are attached individually to a die-cast aluminum manifold, which contains interconnecting passageways. A cut-away view, as well as two schematic diagrams of the Hl?XW300 Series Dryer appear on pages 5 and 7. In standard versions (Normally Closed Valves) compressed air enters the Dryer by means of the energized solenoid valve. The air passes upward through the desiccant chamber immediately above the energized valve. When the air reaches the top of the chamber its direction of flow reverses and it passes downward through the return tube in the center of the chamber, through the open check valve and into the outlet passageway. Most of the dry air is thus delivered into the dry air system, but a portion is diverted for purging the other desiccant chamber. This portion of the dry air passes upward through the purge orifice immediately under the “wet” chamber, up through its return tube, thence downward through the desiccant, where it picks up the moisture contained on the desiccant. It leaves the Dryer by means of the open secondary or purge port of the de-energized valve. At the end of the 30-second half-cycle, the solid state cycle timer de-energizes the valve which had been energized, and energizes the other valve. The main port of the valve thus de-energized closes, shutting off the inlet air stream to its chamber. The secondary or “Purge” port of the same valve now opens, allowing the chamber to depressurize and its purge stream to exit. Simultaneously, the other valve operates to open its desiccant chamber to accept the wet air stream. By means of a special solid state timer, it is possible to pressurize the “dry” chamber several seconds before the “wet” chamber is depressurized. This arrangement serves to reduce the rather severe pressure surge which occurs, especially at the higher pressures, when one chamber depressurizes before the other one has been fully pressurized. The Normally Open Valve unit utilizes essentially the same parts as the Normally Closed unit. The principal difference between the two is that the inlet and purge ports are reversed. In the Normally Open unit, the wet air stream is connected to the secondary or “Normally Open” port of the solenoid valve. The purge gas exits through the Dryer port which serves as the wet gas inlet in the Normally Closed unit. The outlet port is the same in both configurations. The inlet port of the Normally Open Valve is always open when the valve is not energized. Thus, in case of power failure to the Normally Open unit, air will continue to pass through both desiccant chambers so long as pressure is maintained in the inlet air stream.

3.THEORY OF OPERATION

The desiccant used in Puregas Heatless Dryers is a synthetic zeolite known as Molecular Sieves, so named because of its phenomenal ability to retain certain molecules and screen or “sieve” them from a mixture of gases to which it is exposed. Different types of Molecular Sieves differ in their relative capacities for retaining the water molecule. The process of selectively retaining specific molecules from a gaseous mixture is known as “adsorption”, to distinguish it from the process of absorption, in which a liquid is retained in a solid substance, such as cotton fibers or a sponge.

All desiccants are by definition hygroscopic, that is, they attract and retain moisture from air or other gases. Certain materials, such as salts of sodium and calcium are also hygroscopic and are sometimes also referred to as desiccants. However, this type of desiccant upon coming into contact with moist gas, immediately tends to enter into a water sollution with the moisture. Such desiccants are said to be “deliquescent”, and can not be “reactivated” or purged of the water they have retained. As this type of desiccant liquefies, it must be replaced by adding new desiccant in order to maintain drying ability. The adsorbing type of desiccant used in Puregas Heatless Dryers is not consumed in the process of retaining moisture. Rather it may be purged or reactivated millions of times without loss of water adsorption properties.

Adsorption type desiccants may be reactivated or purged of their retained moisture in either of two ways. Until the invention of the Heatless Dryer, the only known method was by raising its temperature to 300˚F or higher, and some Dryers are still manufactured in which the desiccant is reactivated in this manner. For drying large volumes of air at low pressure, where the dry air use does not demand pressures higher than those which can be developed by “blowers” (usually under 2 or 3 PSIG), this type of dryer is frequently used.

In the Puregas Dryer, reactivation is accomplished without the application of heat. The temperature of the desiccant never rises more than a few degrees above the inlet temperature. The obvious advantage of this type of reactivation is the elimination of an external heat source. A not so obvious advantage is that the life of the desiccant is extended, as the heat-reactivated desiccant is subject to degradation at a much greater rate.

Heatless reactivation is possible because the adsorption process is readily reversible. Dry desiccant will adsorb moisture from wet air, and likewise, wet desiccant will give up moisture to dry air. Consequently, it is possible to reactivate the desiccant completely by exposing it to a volume of dry air equal to or greater than the volume of wet air from which moisture had previously been extracted by the desiccant. On the surface, it would appear that the net result of such a reversible process would not produce any usable dry air. Fortunately, by taking advantage of one of the important properties of gas mixtures, it is possible to overcome this obstacle. By expanding a small portion of the pressurized dry gas to atmospheric pressure, we are able to obtain a sufficient volume of dry air to perform the reactivation function. The remainder of the pressurized dry air stream is thus available for the intended purpose. The principle involved was explained briefly in Section I. It is simply that the capacity of air to hold moisture in vapor form at any given temperature depends upon the volume and is independent of pressure. To review briefly, when air is compressed to 100 PSIG, its volume is reduced to approximately one-eighth of the pressurized dry gas stream to atmospheric pressure. This is the portion which is utilized for reactivation purposes. It is fed back through the previously saturated bed of desiccant to remove the moisture accumulated on the desiccant during its previous exposure to the incoming wet gas stream. In actual practice, slightly more than an equal volume of dry gas purge is required. For achieving extremely low dewpoint drying (-100˚ F and lower) the dry gas volume required is approximately double the incoming wet gas volume.

The method of mechanically achieving chamber reversal and purge air feedback in Puregas Heatless Dryers is described above in Section III-2. In describing the method of purging, we note that a portion of the pressurized dry air is expanded through a “purge orifice” in the form of a small hole drilled in a readily removable gland. It is thus possible to vary the amount of purge air being used if operating conditions demand it, by replacing the purge orifice glands with other glands having holes of a different sire.

section IV

Dryer Sizing and Selection

The Puregas Heatless Dryers are divided into two basic series as follows:

1. HF200/300 Series, with standard (NEMA 1) electrical enclosures.
2. HF203 Series, with Explosion-Proof enclosures (NEMA 7 or “Class I, Group D Locations”). These dryers carry a CSA listing under File No. 23136(Class 1, Group B, also available).

Both basic series are illustrated on Page 6 of this Manual. Many different models of each series are available. All models of each series are identical in appearance except for the size of the desiccant chambers. Any model can be completely identified by its 13-digit Model No., as explained in the chart contained in descriptive bulletin No. AP-976E.

All dryers are available for operation on 120 volts or 240 volts and 50 or 60 HZ. However, no single unit is available with dual voltage characteristics.

Both of the basic series of dryers are available in the “normally-open” version. That is, as explained previously in section III-2 the valves are open when not energized. The Model designator for the normally-open unit is the use of the letter B following the third digit of the Model No. (HF3OOB or HF203B).

All HF300 Series units, as well as the HF203B units, may be operated at pressures up to 150 PSIG. The HF2OOA and HF203A units (normally-closed) are rated at 100 PSIG maximum.

In addition to the foregoing variations, dual-mounted, parallel-piped versions of series HF3OOA and HF3OOB are offered, designated as HF315A and HF315B. Each dual dryer has a capacity of twice that of its single component unit. See illustration on Page 6.

In selecting the proper Dryer Series for a given application, specifications of pressure range, electrical characteristics and electrical enclosure requirements must be available.

In addition to selecting the proper Dryer series, it is necessary to select the proper Dryer sire, which is actually a designation of the desiccant chamber length. Chamber lengths of 4”, 6”, 9”, 12” and 20” are offcrcd, and all of the various categories of Dryers are available in all four sixes. It is also necessary to determine the proper purge orifice size or number for any application. Both Dryer sire and orifice number are determined by reference to the sizing charts, which appear in the Appendix and Bulletin No. AP976E.

In order to make the proper selection of Dryer size and purge orifice number, the following information must be at hand.

1. The operating pressure in PSIG.
2. The flow rate (SCFM) required.
3. The dewpoint required at the Dryer outlet.
4. The inlet air temperature.

Three sets of charts are included, for 0° F minus 40° F , minus 100° F outlet dewpoint (atmospheric). For intermediate dewpoints, it is necessary to interpolate. In using the chart, usually the operating pressure is known, as well as the dry air flow requirement. The wet air inlet flow requirement and the purge orifice air requirement is the difference between the wet air inlet flow and the dry air outlet.

All charts are based on an outlet dewpoint referred to atmospheric pressure. In many cases, the user’s dewpoint requirement will be specified at some elevated pressure, which may be anything up to the actual dry air outlet pressure. A dewpoint conversion table is contained in the Appendix. With it a dewpoint may be converted to atmospheric reference from any pressure up to 175 PSIG.

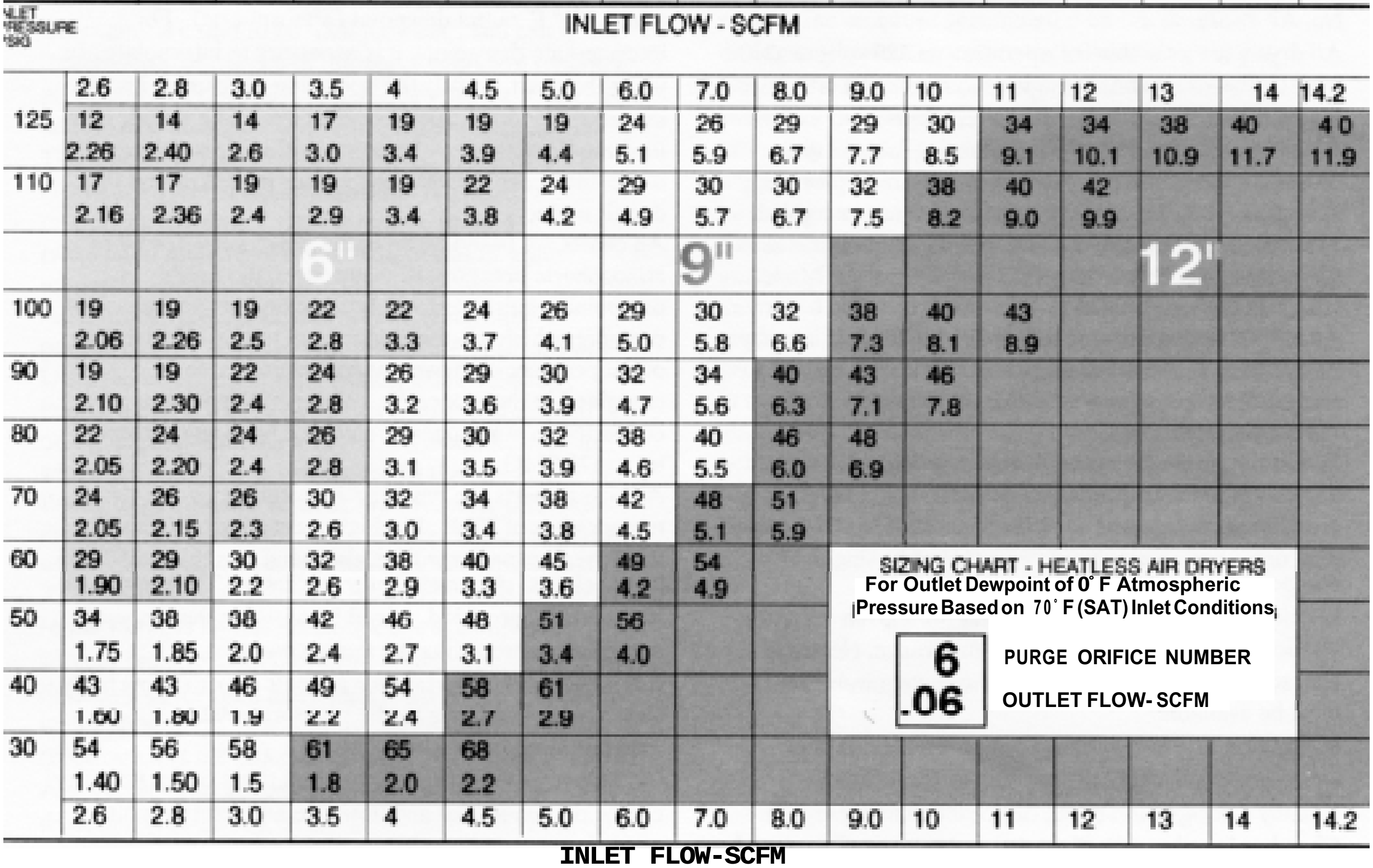
All sizing charts are based on an entering air temperature of 70° F For higher entering temperature the Dryer’s capacity will be somewhat less than indicated by the charts. A convenient temperature “derating” table is, therefore, provided. It will be found in the Appendix, immediately preceding the sizing charts.

It is sometimes important for a Dryer user to know fairly closely what the Dryer outlet pressure will be. Pressure-drop curves are, therefore, provided (contained in the Appendix). From them outlet pressure can be dctemincd for any flow rate and inlet pressure condition.

MAXIMUM OUTLET DEWPOINT O˚ F (ATATMOSPHERIC PRESSURE)

INLET FLOW - SCFM

INLET PRESSURE	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
125	4 .05	4 .15	4 .25	5 .33	5 .43	6 .51	6 .61	6 .71	7 .78	7 .88	9 1.01	10 1.18	10 1.38	11 1.54	11 1.74	12 1.86	12 2.06
110	4 .06	4 .16	5 .24	5 .34	6 .41	6 .51	7 .59	8 .66	8 .76	9 .83	10 1.00	11 1.16	11 1.36	12 1.50	14 1.66	14 1.86	17 1.96
100	4 .66	4 .16	5 .24	5 .34	6 .42	7 .50	8 .57	8 .67	8 .77	10 .82	11 99	12 1.14	14 1.28	14 1.48	14 1.68	17 1.80	17 2.00
90	4 .06	4 .16	5 .25	6 .33	7 .41	8 .48	9 .56	10 .64	10 .74	11 .80	12 .95	12 1.15	14 1.31	17 1.43	17 1.63	19 1.70	19 1.90
80	4 .07	5 .15	6 .24	7 .32	8 .40	10 .45	10 .55	11 .64	11 .72	12 .78	14 .94	14 1.14	17 1.26	17 1.46	19 1.56	19 1.76	22 1.85
70	4 .07	6 .14	7 .23	9 .29	9 .39	10 .47	11 .54	12 .60	12 .70	14 .78	17 .90	17 1.10	19 1.20	19 1.40	19 1.60	22 1.70	22 1.90
60	5 .07	6 .15	8 .22	9 .30	10 .38	11 .46	12 .52	14 .59	14 .69	17 .74	19 .86	22 .95	22 1.15	24 1.30	24 1.50	26 1.62	26 1.82
50	5 .07	7 .14	9 .21	11 .28	12 .35	14 .42	17 .47	17 .57	19 .60	19 .70	22 .81	24 .97	26 1.10	26 1.30	29 1.40	29 1.60	30 1.70
40	6 .07	9 .13	11 .20	12 .27	14 .31	19 .34	19 .44	22 .48	22 .58	24 .65	26 .78	29 .90	30 1.02	30 1.22	34 1.30	38 1.40	40 1.50
30	7 .06	11 .12	14 .18	17 .24	19 .29	22 .33	26 .35	26 .45	26 .55	29 .60	32 .70	34 .80	40 .90	43 1.00	46 1.10	49 1.20	51 1.30
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4



INLET FLOW - SCFM

NLET RESSURE SIG	2.6	2.8	3.0	3.5	4	4.5	5.0	6.0	7.0	8.0	9.0	10	11	12	13	14	14.2
125	12 2.26	14 2.40	14 2.6	17 3.0	19 3.4	19 3.9	19 4.4	24 5.1	26 5.9	29 6.7	29 7.7	30 8.5	34 9.1	34 10.1	38 10.9	40 11.7	4 0 11.9
110	17 2.16	17 2.36	19 2.4	19 2.9	19 3.4	22 3.8	24 4.2	29 4.9	30 5.7	30 6.7	32 7.5	38 8.2	40 9.0	42 9.9			
				6"					9"						12"		
100	19 2.06	19 2.26	19 2.5	22 2.8	22 3.3	24 3.7	26 4.1	29 5.0	30 5.8	32 6.6	38 7.3	40 8.1	43 8.9				
90	19 2.10	19 2.30	22 2.4	24 2.8	26 3.2	29 3.6	30 3.9	32 4.7	34 5.6	40 6.3	43 7.1	46 7.8					
80	22 2.05	24 2.20	24 2.4	26 2.8	29 3.1	30 3.5	32 3.9	38 4.6	40 5.5	46 6.0	48 6.9						
70	24 2.05	26 2.15	26 2.3	30 2.6	32 3.0	34 3.4	38 3.8	42 4.5	48 5.1	51 5.9							
60	29 1.90	29 2.10	30 2.2	32 2.6	38 2.9	40 3.3	45 3.6	49 4.2	54 4.9								
50	34 1.75	38 1.85	38 2.0	42 2.4	46 2.7	48 3.1	51 3.4	56 4.0									
40	43 1.60	43 1.80	46 1.9	49 2.2	54 2.4	58 2.7	61 2.9										
30	54 1.40	56 1.50	58 1.5	61 1.8	65 2.0	68 2.2											
	2.6	2.8	3.0	3.5	4	4.5	5.0	6.0	7.0	8.0	9.0	10	11	12	13	14	14.2

SIZING CHART - HEATLESS AIR DRYERS

For Outlet Dewpoint of 0˚ F Atmospheric Pressure Based on 70˚ F (SAT) Inlet Conditions

6	PURGE ORIFICE NUMBER
.06	OUTLET FLOW- SCFM

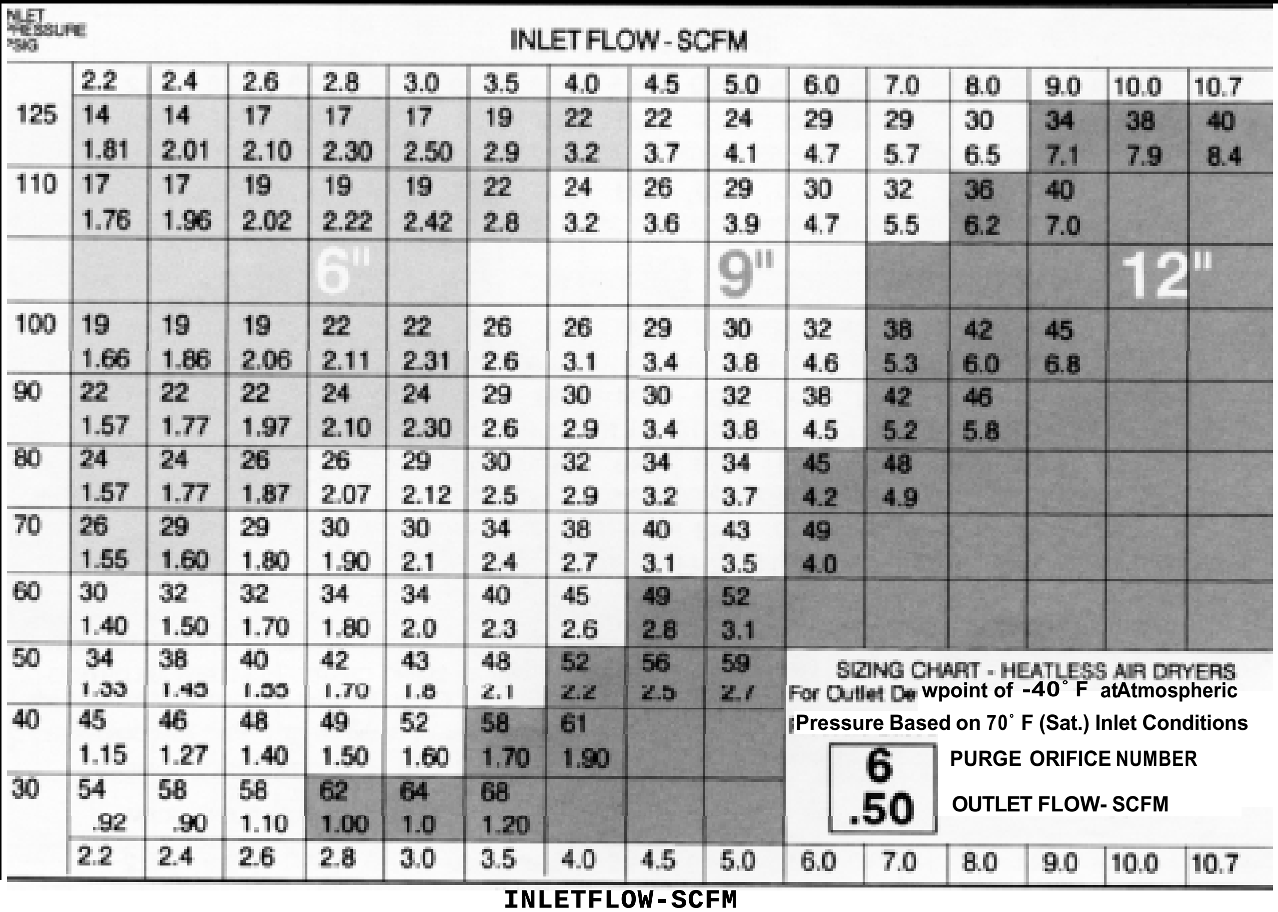
INLET FLOW-SCFM

MAXIMUM OUTLET DEWPOINT-40° F (ATATMOSPHERIC PRESSURE)

INLET

INLET FLOW - SCFM

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0
125	4 .05	4 .15	5 .23	5 .33	6 .41	6 .51	7 .58	7 .68	8 .74	9 .81	10 .98	11 1.13	11 1.33	12 1.46	14 1.61
110	4 .06	4 .16	5 .24	6 .32	7 .39	7 .49	8 .56	9 .63	9 .73	10 .80	11 .97	12 1.10	14 1.26	14 1.46	17 1.56
								6"							
100	4 .06	5 .14	5 .24	7 .30	8 .37	9 .45	9 .55	10 .62	11 .69	11 .79	12 .93	14 1.08	17 1.19	17 1.39	17 1.59
90	4 0.6	5 .15	6 .23	7 .31	8 .38	9 .46	10 .54	11 .61	12 .65	12 .75	14 .91	17 1.03	17 1.23	19 1.31	19 1.51
80	4 .07	5 .15	7 .22	8 .30	9 .37	10 .45	11 .52	12 .58	14 .64	14 .74	17 .86	19 .96	19 1.16	22 1.25	22 1.45
70	4 .07	6 .14	8 .21	9 .29	11 .34	12 .40	12 .50	14 .57	17 .60	17 .70	19 .80	19 1.00	22 1.10	22 1.30	24 1.43
60	5 .07	7 .13	9 .20	11 .26	12 .33	14 .40	17 .44	17 .54	19 .55	19 .65	22 .75	24 .90	26 1.02	26 1.22	29 1.30
50	6 .06	9 .12	11 .18	12 .25	17 .27	17 .37	19 .40	19 .50	22 .51	22 .61	26 .70	29 .80	29 1.00	30 1.10	32 1.20
40	7 .05	11 .lO	14 .15	17 .21	19 .24	19 .34	22 .37	24 .44	26 .48	29 SO	30 .62	32 .75	34 .a7	40 .90	43 1.00
30	9 .04	14 .08	17 .14	22 .14	24 .20	26 .25	29 .28	30 .32	30 .42	32 .45	38 .54	43 .58	46 .68	49 .75	52 .84
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0



NLET PRESSURE PSIG

INLET FLOW - SCFM

	2.2	2.4	2.6	2.8	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	10.7
125	14 1.81	14 2.01	17 2.10	17 2.30	17 2.50	19 2.9	22 3.2	22 3.7	24 4.1	29 4.7	29 5.7	30 6.5	34 7.1	38 7.9	40 8.4
110	17 1.76	17 1.96	19 2.02	19 2.22	19 2.42	22 2.8	24 3.2	26 3.6	29 3.9	30 4.7	32 5.5	36 6.2	40 7.0		
				6"					9"					12"	
100	19 1.66	19 1.86	19 2.06	22 2.11	22 2.31	26 2.6	26 3.1	29 3.4	30 3.8	32 4.6	38 5.3	42 6.0	45 6.8		
90	22 1.57	22 1.77	22 1.97	24 2.10	24 2.30	29 2.6	30 2.9	30 3.4	32 3.8	38 4.5	42 5.2	46 5.8			
80	24 1.57	24 1.77	26 1.87	26 2.07	29 2.12	30 2.5	32 2.9	34 3.2	34 3.7	45 4.2	48 4.9				
70	26 1.55	29 1.60	29 1.80	30 1.90	30 2.1	34 2.4	38 2.7	40 3.1	43 3.5	49 4.0					
60	30 1.40	32 1.50	32 1.70	34 1.80	34 2.0	40 2.3	45 2.6	49 2.8	52 3.1						
50	34 1.33	38 1.45	40 1.55	42 1.70	43 1.8	48 2.1	52 2.2	56 2.5	59 2.7						
40	45 1.15	46 1.27	48 1.40	49 1.50	52 1.60	58 1.70	61 1.90								
30	54 .92	58 .90	58 1.10	62 1.00	64 1.0	68 1.20									
	2.2	2.4	2.6	2.8	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	10.7

SIZING CHART - HEATLESS AIR DRYERS

For Outlet Dewpoint of -40˚ F atAtmospheric Pressure Based on 70˚ F (Sat.) Inlet Conditions

6	PURGE ORIFICE NUMBER
.50	OUTLET FLOW- SCFM

INLETFLOW-SCFM

MAXIMUM OUTLET DEWPOINT-lOO˚F **(AT ATMOSPHERIC PRESSURE)**

INLET FLOW - SCFM

INLET PRESSURE	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0
125	4 .05	4 .15	5 .23	6 .31	7 .38	8 .44	8 .54	9 .61	9 .71	10 .78	11 .94	12 1.06	14 1.21	14 1.41	17 1.50
110	4 .06	5 .14	6 .22	7 .29	8 .36	8 .46	9 .53	10 .60	11 .66	11 .76	12 .90	14 1.05	17 1.15	17 1.35	19 1.41
								6"							
100	4 .06	5 .14	6 .22	7 .30	8 .37	9 .44	10 .52	11 .58	12 .63	12 .73	14 .88	17 .99	17 1.19	19 1.26	19 1.46
90	4 .06	6 .13	7 .21	8 .28	9 .36	11 .40	11 .50	12 .55	12 .65	14 .71	17 .83	17 .90	19 1.10	19 1.30	22 1.37
80	4 .07	6 .14	8 .19	9 .27	11 .32	12 .37	12 .47	14 .54	17 .56	17 .66	19 .75	19 .95	22 1.03	22 1.23	24 1.36
70	5 .06	7 .13	9 .19	11 .24	12 .30	14 .36	14 .46	17 .50	19 .50	19 .60	22 .69	22 .89	24 1.03	26 1.14	29 1.21
60	6 .05	8 .12	10 .18	12 .22	14 .29	17 .33	19 .35	19 .45	19 .55	22 .55	24 .70	26 .82	29 .91	30 1.00	32 1.09
50	7 .04	9 .11	12 .15	14 .22	17 .27	19 .29	22 .31	22 .41	24 .47	26 .50	29 .60	30 .70	32 .81	38 .86	40 .94
40	7 .05	12 .07	17 .lt	19 .14	22 .17	22 .27	26 .24	26 .34	29 .39	30 .43	32 .53	38 .59	42 .65	45 .74	48 .79
30	10 .03	17 .04	19 .09	22 .13	26 .15	29 .19	30 .24	32 .26	34 .30	38 .34	45 .35	49 .35	52 .44	54 .54	58 .53
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.01.	2	1.4	1.6	1.8	2.0

INLET FLOW - SCFM

INLET PRESSURE PSIG	2.2	2.4	2.6	2.8	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	9.2	
125	17 1.70	17 1.90	19 1.95	19 2.15	19 2.35	22 2.65	24 3.05	26 3.40	29 3.70	30 4.55	32 5.3	34 6.1	38 6.9	40 6.9	
110	19 1.61	19 1.81	22 1.85	22 2.05	24 2.16	26 2.55	29 2.85	29 3.35	32 3.55	34 4.30	38 5.1	42 5.8			
			6"				9"						12"		
100	22 1.51	22 1.71	22 1.91	24 2.03	26 2.11	29 2.45	30 2.80	32 3.10	32 3.60	38 4.30	42 5.0				
90	22 1.57	24 1.70	26 1.79	29 1.83	29 2.03	30 2.45	32 2.70	34 3.10	38 3.45	43 4.10	46 4.80				
80	26 1.46	29 1.52	29 1.72	30 1.80	32 1.90	34 2.22	38 2.60	40 2.95	43 3.25	48 3.90					
70	30 1.30	32 1.40	32 1.57	34 1.66	34 1.86	40 2.11	43 2.44	46 2.70	48 3.10						
60	34 1.20	38 1.29	38 1.49	40 1.58	42 1.70	46 1.94	49 2.20	52 2.55	56 2.70						
50	42 1.08	43 1.21	46 1.25	48 1.35	49 1.45	54 1.64	58 1.83								
40	49 .90	52 .98	54 1.03	56 1.13	58 1.17	61 1.38									
30	61 .48	62 .56	64 .64	65 .72	68 .70										
	2.2	2.4	2.6	2.8	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	9.2	

SIZING CHART - HEATLESS AIR DRYERS

For Outlet Dewpoint of – 100° F at Atmospheric Pressure Based on 70˚ F (Sat) Inlet Conditions

8	**PURGE ORIFICE NUMBER**
.44	**OUTLET FLOW - SCFM**

INLETFLOW-SCFM

PUREGAS SIZING CHARTS FOR SERIES HF200/300-20" HEATLESS DRYERS

INLET FLOW - SCFM

INLET PRESSURE - PSIG

		3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0
HF300	125									42 7.7	45 8.4	48 9.1	49 9.9	52 10.7	54 11.4								
	110								45 6.7	48 7.4	51 8.1	54 8.7	56 9.4	58 10.2									
	100							48 5.7	51 6.3	52 7.2	56 7.8												
	90							52 5.4	54 6.2	58 6.8													
	80						54 4.4	58 5.0	59 5.8														
HF200/300	70					54 3.7	58 4.3	62 4.8															
	60					61 3.2	64 3.9																
	50			62 1.90	62 2.4	68 2.9																	
	40		65 1.55	68 1.75	73 1.90																		
	30	73 0.90	75 1.10																				
		3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0

For Outlet Dewpoint of – 100˚ F at Atmospheric Pressure Based on 70˚ F (Sat.) Inlet Condition

58 PURGE ORIFICE NUMBER

4.3 OUTLET FLOW- SCFM

INLET PRESSURE - PSIG

		3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0
HF300	125										42 8.6	45 9.4	46 10.2	48 11.0	51 11.8	52 12.7	54 13.3	54 14.1					
	110									45 7.8	48 8.4	49 9.3	52 10.1	54 10.8	56 11.6	58 12.4							
	100									48 7.6	52 8.3	54 9.1	58 9.6										
	90								51 6.6	54 7.3	58 7.9	59 8.7											
	80							54 5.5	56 6.3	58 7.1	61 7.8												
HF200/300	70						54 4.7	59 5.2	61 6.0	64 6.6													
	60					56 3.8	61 4.3	64 5.0															
	50					64 3.3	70 3.8																
	40			64 2.2	68 2.3	73 2.9																	
	30		73 1.40	75 1.70																			
		3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0

For Outlet Dewpoint of -40˚ F at Atmospheric Pressure Based on 70˚ F (Sat.) Inlet Condition

61 PURGE ORIFICE NUMBER

6.0 OUTLET FLOW - SCFM

INLET PRESSURE - PSIG

		3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0
HF300	125														45 12.6	46 13.4	48 14.	49 15.1	51 16.0	52 16.9	54 17.6	56 18.4	58 19.1
	110												46 10.6	48 11.5	51 12.3	52 13.2	54 14.0	58 14.6	58 15.7	61 16.3			
	100											48 9.8	51 10.6	54 11.3	56 12.2	58 13.1	61 13.8						
	90										51 8.7	54 9.4	58 10.1	59 11.0	62 11.7	64 12.6							
	80									54 7.6	56 8.5	59 9.2	62 9.9	64 10.8									
HF200/300	70								58 6.5	59 7.4	62 8.0	65 8.7	70 9.5										
	60							59 5.6	62 6.4	65 7.1	70 7.8												
	50						62 4.7	67 5.3	71 5.9	74 6.6													
	40					65 3.7	70 4.4	75 5.0															
	30				75 2.6	75 3.2																	
		3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0

For Outlet Dewpoint of 0° F at Atmospheric Pressure Based on 70° F (Sat.) Inlet Condition

62 PURGE ORIFICE NUMBER

8.0 OUTLET FLOW - SCFM

INLET FLOW - SCFM

SIZING CHART FOR HF3OOB
(NORMALLY OPEN VALVES)
INLET PRESSURE 150 PSIG DRYER

MAXIMUM OUTLET -40˚F DEWPOINT (AT ATMOSPHERIC PRESSURE)

Inlet Flow SCFM	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.5	4.0
Outlet Flow SCFM	.04	.14	.24	.32	.39	.46	.56	.66	.71	.81	.98	1.14	1.29	1.41	1.61	1.8	1.94	2.01	2.21	2.41	2.75	3.0
Puge Orifice **Number**	4	4	4	5	6	7	7	7	8	8	9	10	11	12	12	12	14	17	17	17	19	22
DRYER MODEL	HF 300B 06"																					

MAXIMUM OUTLET -40˚ F DEWPOINT (AT ATMOSPHERIC PRESSURE)

Inlet Flow SCFM	4.5	5.0	6.0	7.0	8.0	8.9	9.0	10	11	12	13	14	15	16	17	18	18.6
Outlet Flow SCFM	3.5	4.0	4.8	5.6	6.5	7.0	7.1	7.9	8.7	9.4	10.2	11.1	11.7	12.6	13.4	14.	14.7
Puge Orifice **Number**	22	22	26	28	29	32	32	34	38	42	43	45	48	49	52	54	54
DRYER MODEL	HF 300B 09"						HF 300B 12"			HF 300B 20"							

MAXIMUM OUTLET – 100˚ F DEWPOINT (AT ATMOSPHERIC PRESSURE)

Inlet Flow SCFM	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.5
Outlet Flow SCFM	.04	.14	.22	.29	.39	.46	.56	.61	.68	.78	.94	1.01	1.21	1.41	1.54	1.61	1.81	2.01	2.21	2.25	2.75
Puge Office Number	4	4	5	6	6	7	7	8	9	9	10	12	12	12	14	17	17	17	17	19	19
DRYER MODEL	HF 300D 06"																				

MAXIMUM OUTLET – 100° F DEWPOINT (AT ATMOSPHERIC PRESSURE)

Inlet Flow SCFM	4.0	4.5	5.0	6.0	7.0	7.4	8.0	9.0	10	11	12	13	14	15	16
Outlet Flow SCFM	3.0	3.5	3.9	4.6	5.5	5.7	6.1	6.9	7.7	8.5	9.2	10.0	10.6	11.5	12.2
urge Orifice Number	22	22	24	28	29	30	32	34	38	40	43	45	48	49	52
DRYER MODEL	HF 300B 09"						HF 300B 12"			HF 300B 20"					

MAXIMUM OUTLET 0˚ F DEWPOINT (AT ATMOSPHERIC PRESSURE)

Inlet Flow SCFM	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.5	4.0	4.5	5.0	5.9
Outlet Flow SCFM	.04	.14	.24	.34	.42	.49	.59	.66	.76	.86	1.01	1.18	1.34	1.54	1.69	1.89	2.01	2.21	2.34	2.54	2.91	3.25	3.75	4.25	4.9
Puge Office **Number**	4	4	4	4	5	6	6	7	7	7	8	9	10	10	11	11	12	12	14	14	17	19	19	19	22
DRYER MODEL	HF 200N 06"																								

MAXIMUM OUTLET 0˚ F DEWPOINT (AT ATMOSPHERIC PRESSURE)

Inlet Flow SCFM	6.0	7.0	8.0	9.0	10	10.5	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0
Outlet Flow SCFM	4.9	5.9	6.6	7.3	8.3	8.6	8.9	9.7	10.6	11.4	12.2	13.0	14.0	14.8	15.6	16.4	17.1
urge Orifice Number	24	24	28	30	30	32	34	38	40	42	45	46	46	48	49	52	54
DRYER MODEL	HF 300B 09"						HF 300B 12"			HF 300B 20"							

All chart figures based on an inlet pressure of 150 PSIG and 70˚ F (Sat) inlet condition.

section V

Installation of Puregas Heatless Dryers

1. GENERAL

Any Desiccant Type Dryer, including the Heatless Dryer, should be installed in the coolest practicable location that is not subject to freezing temperatures. These Dryers operate most efficiently at the lower temperatures, but temperatures under 32° F could result in freezing of the moisture as it condenses in the line ahead of the Dryer and within the Dryer itself. This in turn could result in complete or partial blockage of the air stream or damage to the equipment, or both. Standard, catalog Models of Heatless Dryers should not be subjected to ambient or inlet gas temperatures above 125° F. If excessive temperatures cannot be avoided, special equipment is required.

In this manual, only certain fundamental concepts of Dryer installation are discussed. A Dryer should not be installed without careful reference to the Installation Instructions furnished with the Dryer. The instructions arc complete and should bc followed carefully to obtain the most satisfactory operation from the Dryer.

A Typical Installation Diagram appears on page 16. It depicts all of the essential elements of a good Dryer installation, as well as certain optional features which arc discussed herein below.

2. FILTERS

Particles of dirt, rust or scale, as well as condensed moisture or oil that may be in the gas line feeding the Dryer should be removed from the gas stream before it enters the Dryer. This can usually best be accomplished by means of a bowl type “in-line” filter, which should be installed as close to the Dryer as possible. For best results, a filter element with a rating of 25 microns or finer should be used. The tilter should be sized carefully with respect to pressure drop at the anticipated operating conditions of flow rate and pressure.

Where an appreciable amount of oil is present in the feed line, a tilter element with oil absorbing properties i recommended. The use of two filters in series will usually result in considerable extended maintenance intervals. Where oil is present and two filters are used, the upstream filter can be of ordinary design for removal of dirt and the bulk of condensed oil and moisture. The oil coalescing downstream filter will then more effectively protect the Dryer from oil contamination.

Manual drain type tilter bowls are usually equipped wit a drain cock so that the accumulated impurities can be removed without dismantling the filter. It is important include periodic draining of tilter bowls in routine maintenance schedules. This should be accomplished a least weekly-preferably on a daily basis. Automatic draining devices are available for use in conjunction wit filters to avoid the frequent maintenance required by manually drained filters Even these devices must be cleaned or flushed occasionally to avoid clogging, but this is usually a matter of monthly or quarterly attention.

3. BY-PASS

This is an optional feature that makes possible continuous air service during Dryer service periods, or even with the Dryer removed from the line. In order for the By-Pass to function properly, the two Dryer shut-of valves plus the By-Pass valve are required.

4. THROTTLING VALVE

In any installation serving equipment that operates at atmospheric pressure or at any pressure appreciably lower than the Dryer inlet pressure, some means of throttling or controlling the flow in the system is required. It is frequently unnecessary to use both a throttling valve and a regulator.

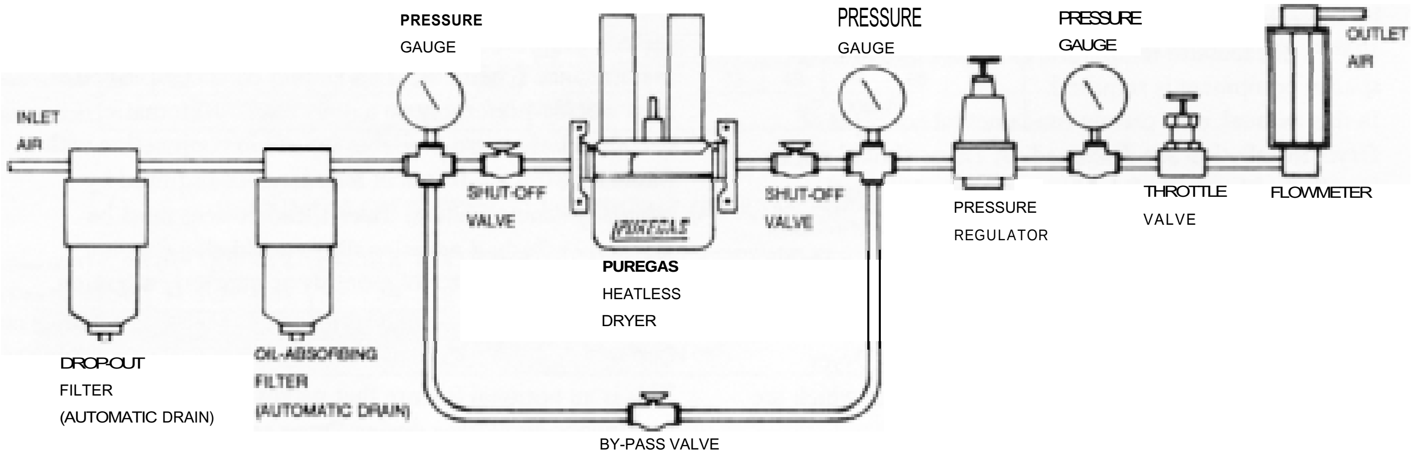
5. INSTRUMENTATION

The Instrumentation shown in the Typical Installation Diagram is all optional. However, in most installations, all items shown would be of some benefit, and the actual decision regarding their use should be based on the particular requirements of the specific application. In many cases, the primary purpose of instruments is in troubleshooting, and at such times they often serve to reduce greatly the time required to analyze problems, and thereby usually prove to be well worth the initial cost of including them in the installation.

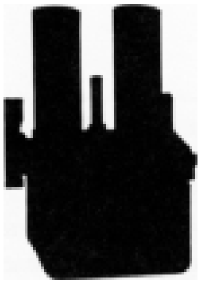
The main purpose of pressure gauges is self-evident. In any drying operation, it is important that nominal operating pressure be maintained at the Dryer inlet in order to insure efficient drying service. With a pressure gauge also immediately downstream of the Dryer, the pressure drop through the Dryer can readily be observed and may be used as a rough indication of the gas flow through the Dryer. If the system pressure at point of usage is at all important, a pressure gauge should be installed downstream of the regulator. Many regulators are equipped with extra pipe taps for gauges in the regulator outlet chamber. If no regulator is used, and especially if no flow meter is used a pressure gauge may be essential downstream of the throttling valve.

A regulator is required in cases involving constant dry air pressure requirement and varying flow conditions. A regulator may not be required if the downstream pressure is not critical and if the equipment in the system will withstand the full line pressure under static conditions.

A flowmeter is required if it is necessary to know the exact amount of dry air being fed into a system. It may also be advisable in cases wherein the entire capacity of the Dryer is required, but no other means is provided to guard against Dryer overload. In cases wherein the dry air requirement is constant, and the Dryer inlet pressure is fairly stable, a fiied orifice in the Dryer outlet line may be substituted for both the throttling valve and the meter.



FACTORY RECOMMENDED DRYER INSTALLATION DIAGRAM



section VII

Other types of Dryers:
Their Advantages and Disadvantages

1. HEAT-REACTIVATED "DESICCANT" TYPE

The same basic “adsorption” principle is employed in this type of dryer as in the “Heatless” Dryer, and any of the moisture absorbents may be used (molecular sieves, silica gel or activated alumina are the most common). As the title implies, heat is used to remove the moisture from the saturated desiccant. Heat is applied by means of either heaters embedded in the desiccant or an externally heated gas stream. Heaters may be either electric or steam. Either dry gas reflux or a completely separate reactivation gas stream may be used, depending upon the effluent dewpoint requirement.

Most dryers of this type made today are “dual-tower” to provide continuous drying, and most are either fully or semi-automatic.

2. REFRIGERATION TYPE

This type of dryer removes moisture from gas by cooling to within a few degrees of the freezing point of water. The resultant condensed moisture is removed in a separator and drain trap mechanism located immediately downstream of the refrigerant evaporator. The minimum dewpoint achievable with this type of dryer is 35° to 40° F (at pressure) because there is danger of freeze-up at lower temperatures.

3. DELIQUESCENT TYPE

This type of dryer uses a hygroscopic salt as “desiccant”, (usually sodium chloride, calcium chloride, urea or a combination of the three). The salt dissolves in the moisture it absorbs from the gas. Consequently, in this type of dryer the desiccant cannot be reactivated but must be replaced periodically. These dryers are sometimes referred to as chemical dryers.

4. ADVANTAGES AND DISADVANTAGES

A. The Puregas Heatless Dryer is smaller and lighter than the heat-reactivated and the refrigeration types with comparable ratings, and is easier to handle, transport and install. Its first cost is lower than that of a heat-reactivated dryer of comparable rating and approximately the same as that of a refrigeration type. The cost of operating a Heatless Dryer is especially low, because the total power requirement is only 20-75 watts, depending upon the model, compared with 500 watts or more for the smallest heat-reactivated dryer and several KW for one in the capacity range of the Puregas High Capacity Series Dryers. However, the dry air purge requirement for the Heatless Dryer is somewhat greater than that required by a dryer with imbedded heaters. The two solenoid valves are the only moving parts in a Heatless Dryer. The parts used have been selected for their exceptionally high reliability, which accounts for very low maintenance costs. The desiccant rarely has to be replaced unless it becomes oil contaminated, and when replacement is necessary the amount of desiccant required is extremely small because of the very short chamber reversal cycle used in the Heatless Dryer. One of the main advantages of the Heatless Dryer is its ability to achieve extremely low dewpoints (well under minus 100° F) Such low dewpoints cannot be achieved with refrigeration or deliquescent type dryers under any conditions, and with heat-reactivated dryers only under carefully controlled conditions, including high pressure, low inlet temperature and very high reactivation temperature.

B. Heat reactivated dryers have the ability to produce low dewpoints even with relatively low operating pressures. This is essentially the only advantage of this type of dryer over the Heatless type, which depends upon pressure differential for desiccant reactivation. In heat reactivated dryers, the desiccant is subject to degradation at a substantially greater rate than in Heatless Dryers, especially where low dewpoints are required, necessitating the use of very high reactivation temperatures. Frequent heater replacement also tends to be a problem with this type of dryer. Because it is necessary to operate these dryers on extended cycles (6-hour full cycles or longer), much larger desiccant beds are required than with Heatless Dryers. This results in a larger, heavier and more expensive dryer to do a given job. In addition, when the desiccant must be replaced, the quantity required is much greater, which inevitably results in higher maintenance cost.

C. The application of refrigeration type dryers is limited because of their inability to produce low dewpoints. However, for some purposes, 35° to 40° F dewpoint at drying pressure is sufficient, in which case the refrigeration type dryer may be used to advantage. Also, the refrigeration type dryer is sometimes used as a first stage of drying ahead of a desiccant type dryer.

Other disadvantages to the refrigeration type dryer are its size and weight and its requirement for providing a method of disposing of the condensate, all of which make this type of dryer more difficult to handle, transport and install than the Heatlesstype.

In the smaller sizes, using hermetically sealed refrigerant compressors (up to about 1 HP), the reliability of these units is fairly good. However, the cooling surfaces tend to become fouled with dirt and oil thus reducing the unit's drying efficiency, and the condensate release mechanism may fail to function, rendering the unit completely ineffective as a dryer.

D. Deliquescent type dryers are single bed, non-cycling, non-reactivating units, which are less expensive to construct than any of the other three types. However, because the desiccant is consumed, it must be replaced on a routine basis. This results in a high operating cost which completely offsets any advantage derived from the lower initial cost. Other disadvantages to the deliquescent type dryer are:

1. Low dewpoints are not attainable, even at relatively low temperatures. Above 100° F., drying capability is almost negligible.
2. Effluent dewpoint deteriorates as the desiccant is consumed between replenishments.
3. Salt carry-over into the air pipeline may be corrosive to the pipeline as well as to the equipment using the air.

APPENDIX

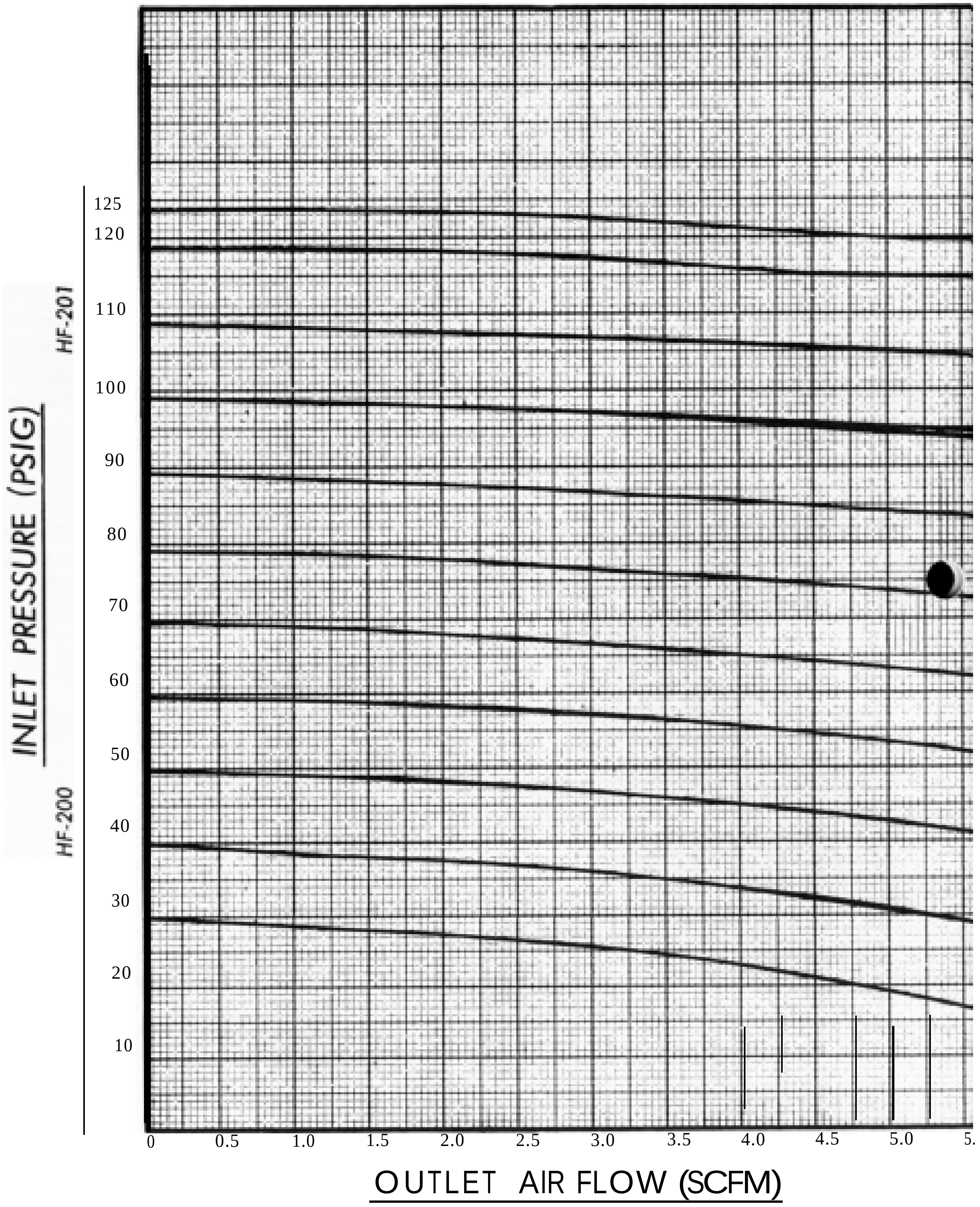
TABLE OF MOISTURE CONTENT
VS. DEW-POINT TEMPERATURE

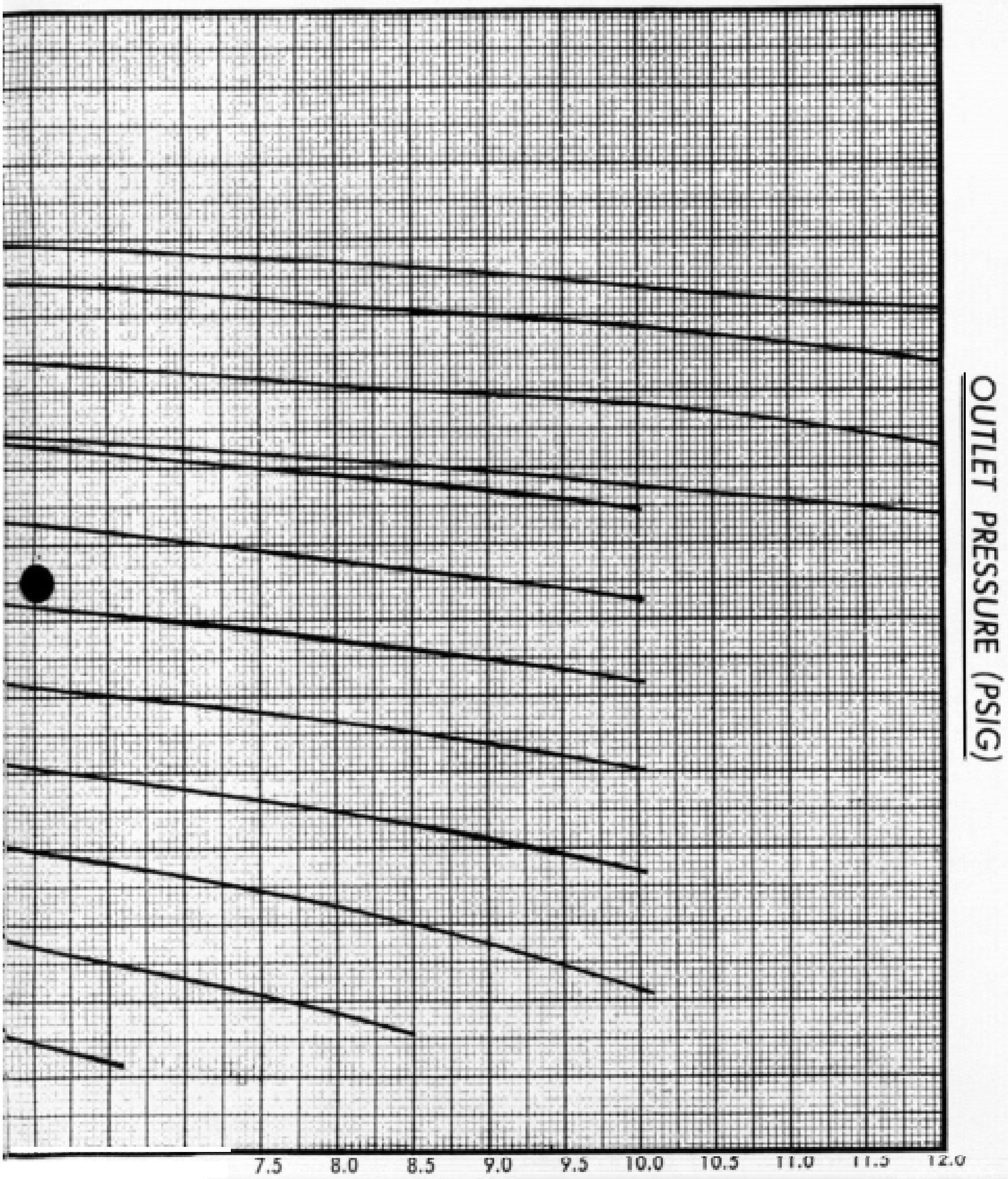
Moisture Content of Saturated Air or Other Gas at Various Temperatures (Dew-Points) and at 1 Atmosphere Absolute Pressure *(14.7* PSIA)

Dew-Point Temperature		Moisture Content Per Cent by Volume*	*Dew-Point* Temperature F.	C.	Moisture Content *Per Cent* by Volume*
110	43.3	8.70	16	-8.9	0.308
108	42.2	8.20	14	-10.0	.282
106	41.1	7.75	12	-11.1	.258
104	40.0	7.30	10	-12.2	.236
102	38.9	6.90	8	-13.3	.216
100	37.8	6.50	6	-14.4	.198
98	36.7	6.10	4	-15.6	.180
96	35.6	5.75	2	-16.7	.165
94	34.4	5.40	0	-17.8	.150
92	33.3	5.05	-2	-18.9	.136
90	32.2	4.75	-4	-20.0	.124
88	31.1	4.46	-6	-21.1	.113
86	30.0	4.18	-8	-22.2	.102
84	28.9	3.92	-10	-23.3	.093
82	27.8	3.68	-12	-24.4	.084
80	26.7	3.44	-14	-25.6	.076
78	25.6	3.22	-16	-26.7	.0685
76	24.4	3.02	-18	-27.8	.0619
74	23.3	2.84	-20	-28.9	.0558
72	22.2	2.65	-22	-30.0	.0503
70	21.1	2.47	-24	-31.1	.0452
68	20.0	2.31	-26	-32.2	.0407
66	18.9	2.16	-28	-33.3	.0364
64	17.8	2.02	-30	-34.4	.0328
62	16.7	1.86	-32	-35.6	.0294
60	15.6	1.75	-34	-36.7	.0264
58	14.4	1.63	-36	-37.8	.0235
56	13.3	1.51	-38	-38.9	.0210
54	12.2	1.40	-40	-40.0	.0188
52	11.1	1.30	-42	-41.1	.0167
50	10.0	1.21	-44	-42.2	.0149
48	8.9	1.12	-46	-43.3	.0132
46	7.8	1.04	-48	-44.4	.0117
44	6.7	0.966	-50	-45.6	.0104
42	5.6	.894	-52	-46.7	.0092
40	4.4	.827	-54	-47.8	.0082
38	3.3	.765	-56	-48.9	.0072
36	2.2	.707	-58	-50.0	.0063
34	1.1	.653	-60	-51.1	.0056
32	0.0	.602	-65	-53.9	.0041
30	-1.1	.553	-70	-56.7	.0029
28	-2.2	.511	-75	-59.4	.0021
26	-3.3	.472	-80	-62.2	.0015
24	-4.4	.434	-85	-65.0	.0010
22	-5.6	.398	-90	-67.8	.0007
20	-6.7	.367	-95	-70.6	.0005
18	-7.8	.337	-100	-73.3	.0003

I vap pressures in atmospheres at various dew-point temperatures can be obtained by dividing the values for per cent by volume, given in this table, by 100.

Pressure Drop - HEATLESS AIR DRYERS




OUTLET PRESSURE (PSIG)
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0

DEWPOINT CONVERSION TABLE

ATMOS DEWPOINT		EQUIVALENT DEWPOINT (˚F) AT PRESSURE (PSIG)							
Vol. %	(˚F)	5	10	15	2Q	25	30	40	50
1.210	50	58	64	70	74	78	82	88	94
.453	25	32	38	42	47	50	54	59	64
.150	0	6	12	16	19	22	25	30	34
.0558	-20	-14	-10	-6	-3	0	2	7	11
.0188	-40	-35	-31	-27	-24	-22	-20	-16	-12
.0056	-60	-55	-52	-49	-46	-44	-41	-38	-35
.0015	-80	-76	-73	-70	-68	-65	-63	-60	-57
.0003	-100	-97	-95	-93	-90	-88	-87	-84	-82

Vol. %	(˚ F)	60	70	80	90	100	125	150	250
1.210	50	98	102	106	110	113	-	-	
.453	25	68	72	75	78	81	87	921	108
.150	0	38	41	44	46	48	55	59	72
.0558	-20	14	17	20	22	24	29	33	45
.0188	-40	-10	-7	-5	-2	0	4	7	18
.0056	-60	-33	-30	-28	-26	-25	-21	-18	-8
.0015	-80	-55	-53	-51	-50	-48	-45	-42	-34
.0003	-100	-80	-78	-77	-75	-74	-70	-67	-60

PUREGAS HEATLESS AIR DRYERS

TABLE OF CAPACITY REDUCTION FOR INLET TEMPERATURES IN EXCESS OF 70° F

CAPACITY REDUCTION IN % OF CAPACITY
AT 70˚F Inlet TEMPERATURE

Inlet Temperature F	OPERATING PRESSURE (PSIG) 50	75	100	125
FOR 0˚ F OUTLET DEWPOINT CHART				
90	25	25	25	25
105	45	40	40	35
125	50	45	45	40
FOR MINUS 40˚ F OUTLET DEWPOINT CHART				
90	15	15	15	15
105	40	30	30	30
125	45	40	35	35
FOR MINUS 100˚ F OUTLET DEWPOINT CHART				
90	15	10	10	10
105	35	30	25	25
125	40	35	30	30

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