1. General Description

1.1. INTRODUCTION

The purpose of this document is to describe the operating principle and the principal components of Ingersoll Rand high pressure refrigerated dryers. They are non-cycling compressed air dryers designed for superior and reliable performance in a compressed air solution.

1.2. OPERATING PRINCIPLE

Dryers are split into a compressed air circuit and a refrigeration circuit.

1.2.1. COMPRESSED AIR OPERATING PRINCIPLE

1.2.1.1. AIR COOLED

Saturated compressed air enters the dryer's heat exchanger, where it is pre-cooled by the cold compressed air exiting the dryer. Then it passes to the evaporator, where it is further cooled by the cold evaporating refrigerant (Tab.1):

Tab.1

Model	Type of refrigerant	Quantity of Heat Exchangers
D54IN-HP to D660IN-HP	R134a	1

The cold air and condensed liquids flow to the de-mister separator, where the liquids are separated out of the air-stream by the de-mister's mesh filter.
The liquids are then drained away by a Timed or no-loss condensate drain (Tab.1).
The now dry but still cold compressed air exits the dryer via the air-to-air heat-exchanger.
As it cools the incoming air, it is itself warmed up, thereby eliminating condensation accumulation on the outside of the air piping and decreasing the relative humidity.

1.2.2. REFRIGERATION CIRCUIT

The refrigeration circuit begins at the discharge of the refrigerant compressor; the hot high pressure gas flows through towards the air/water-cooled condenser.
Here the refrigerant is cooled by ambient air/water flowing across the condenser coil, causing the gas to condense into a liquid state. On exiting the condenser the liquid refrigerant passes through the filter/dryer, where any moisture and impurities within the refrigerant are removed. Next the refrigerant passes through the capillary. The capillary expands the high pressure refrigerant before entering the evaporator. The cold liquid refrigerant then enters the evaporator, where it exchanges heat with hot compressed air.
It adsorbs heat from the compressed air and cools the compressed air to the required dew point temperature, allowing the vapour into the saturated air to condense into water droplets which will be further discharged.
As the refrigerant flows through the evaporator it transforms from a cold liquid to a warm (and superheated) gas.
The warm refrigerant gas then exits the evaporator and returns back to the refrigerant compressor, where it repeats the whole above cycle again.

1.2.3. CAPACITY

1.2.3.1. D54IN-HP TO D660IN-HP

	ISO 8573-1: 2001 Class 5 < 7° C Pressure Dew Point		ISO 8573-1: 2001 Class 4 < 3° C Pressure Dew Point	
50 Hz Model	m^3/min	m^3/hr	m^3/min	m^3/hr
D54IN-HP	0.90	54	0.72	43.2
D72IN-HP	1.20	72	0.96	57.6
D108IN-HP	1.80	108	1.44	86.4
D144IN-HP	2.40	144	1.92	115.2
D180IN-HP	3.00	180	2.40	144
D270IN-HP	4.50	270	3.20	192
D360IN-HP	6.00	360	4.80	288
D480IN-HP	8.00	480	6.40	384
D660IN-HP	11.00	660	10.00	600

Data refers to the following conditions:

- Ambient temperature = 25 ºC
- Air inlet temperature = 35 ºC
- Pressure = 40 bar g

Operating Capabilities:

Maximum operating pressure		= 40 bar (g)
Maximum air inlet temperature		= +45°C
Ambient temperature	Min/Max	= +2°/+45°C
Electrical protection		= IP42

2. COMPONENTS AND CONSTRUCTION

Each dryer are designed with the following components.

2.1. D54IN-HP TO D660IN-HP

2.1.1. REFRIGERANT COMPRESSOR

A hermetically sealed reciprocating compressor is utilized throughout the design. All compressors have an oil sump heater with primary external motor temperature protection and internal, secondary motor temperature protection. A primary, external sensor with secondary, internal protection protects compressor discharge temperature. Installing the compressor on isolation mounts to the base plate reduces noise and vibration.

2.1.2. HEAT EXCHANGER

Each dryer uses an aluminum plate heat exchanger. The heat exchanger contains three main sections. The precooler/reheater section cools the warm incoming air with cold air leaving the evaporator section. The evaporator section is an air to refrigerant heat exchanger that cools the compressed air to the desired dew point temperature. The separator utilizes a stainless steel demister to ensure maximum efficiency under all operating conditions.

The heart of any refrigerated dryer is the heat exchanger. The 3 in 1 heat exchanger has been designed specifically for this application. As a result, maximum heat transfer capability can be

achieved with a minimum pressure drop. The precooler/reheater cools the incoming air with the air leaving the refrigeration section.

The evaporator section is where the air is cooled by the refrigerant. After leaving the evaporator, the water gets physically removed by an extremely effective stainless steel demister.

The heat exchanger is fabricated with corrosion resistant aluminum resulting in years of trouble free operation.

The demister as mentioned before removes the moisture along all the section of the condenser as opposed to other solution where the moisture is removed only in the final zone. This technical advantage reduces the energy consumption and assists keeping the dew point stable.

2.1.3. LIQUID SEPARATOR

The liquid separator has the task of ensuring that no liquid refrigerant enters the compressor. It improves the stability of the dew point and it reduces the energy consumption of the unit.

2.1.4. CONDENSER

An air cooled refrigerant condenser is standard on all models. This condenser, which includes aluminum finned tubing, will be cooled by means of a variable speed fan which allows adjustment of the refrigeration effectiveness in relation to the current demand.
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2.1.4.1. VARIABLE SPEED FAN (D54IN-HP TO D480IN-HP)

Dryers are cooled by an axial variable speed fan installed on top of each unit. This unique variable speed fan automatically adjusts cooling capacity to match load requirements. The fan dissipates heat of the dryer and is controlled by the dryer controller. There is no frequency drive required, which simplicity of our dryers. The fan is located on the top of the units to improve air flow and ease of maintenance.

2.1.5. HOT GAS BY-PASS VALVE

2.1.5.1. D270IN-HP TO D480IN-HP

The cooling capability is performed through the combination of the variable speed fan and a hot gas bypass valve. To ensure that there is no risk of freezing within the dryer a hot gas by-pass valve acts as the controller for the whole refrigeration circuit. The hot gas by-pass operates according to the refrigerant pressure within the evaporator. It reacts by taking a percentage of the refrigerant exiting the refrigerant compressor, and re-injecting it into the compressor inlet. In this way the hot gas by-pass can ensure that the pressure of the refrigerant entering the evaporator is always constant. This ensures a stable refrigeration circuit regardless of changes in operating conditions.

2.1.5.2. D660IN-HP

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2.1.6. FAN PRESSURE SWITCH

2.1.6.1. D660IN-HP

The fan pressure switch allows the cooling fan to the dryer's cooling capacity at different working conditions. Condensation pressure is controlled by the control panel’s activation and deactivation

of the fans. The fan pressure switch deactivates the fan when the pressure is lower than 16 bars and reactivates it when the pressure is higher than 20 bar.

2.1.7. CONTROL PANEL

2.1.7.1. D54IN-HP TO D660IN-HP

A full feature electronic control system ensures proper dryer operation. Individual alarms are provided for high and low dew point and probe failure. The control board is equipped with a dry contact for common alarm and alarm history is available for review. The condensate set points can be adjusted on the panel. A visual display is used to indicate dryer load condition. Three LED's are provided to indicate compressor, drain and condenser fan status. An energy saving mode will shut the dryer off during periods of low demand.

2.1.8. ENCLOSURE

The cabinet is designed to safely contain components yet offer an aesthetically pleasing appearance and ergonomically planned maintenance access. The sheet metal enclosure is steel and is painted with electro-statically applied powder coat paint.

2.1.9. TESTING

Final package and functional testing is performed on all dryers:

- Electrical functionality test
- Helium leak test to the refrigeration side
- Refrigeration leak test at designed system pressure