Membranes N2 Gas Generators

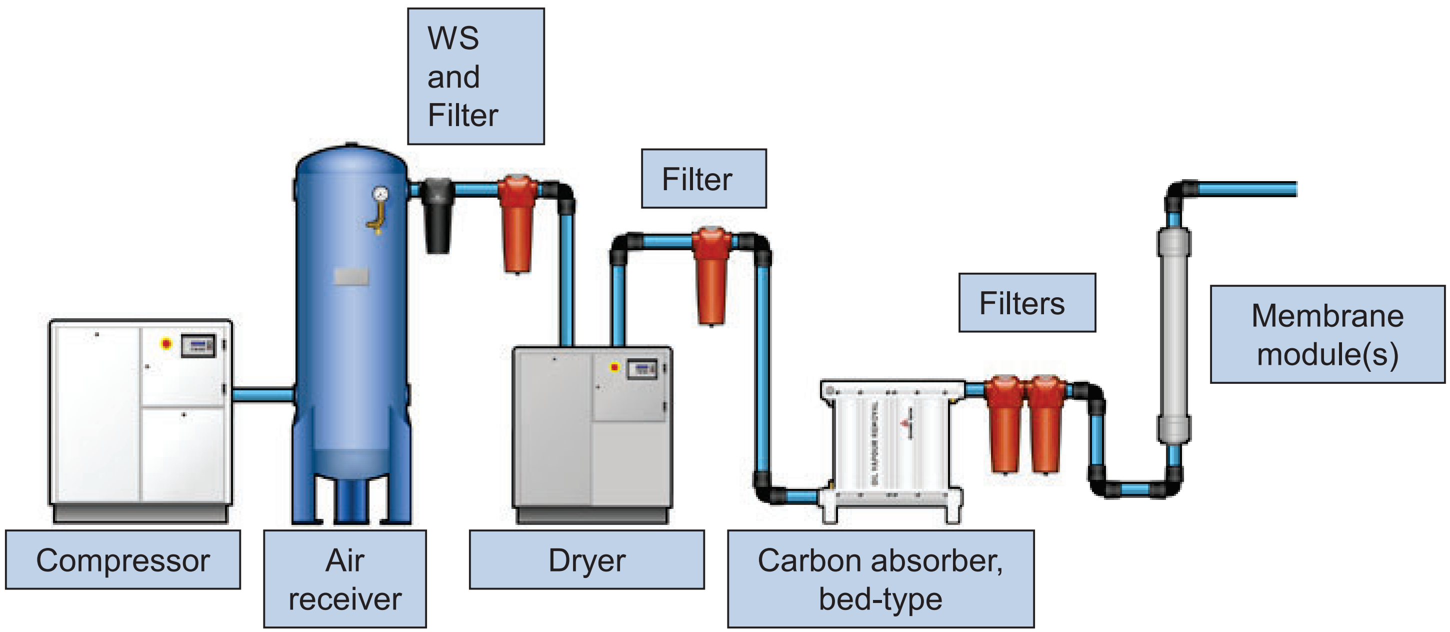
Parker domnick hunter

ENGINEERING YOUR SUCCESS.

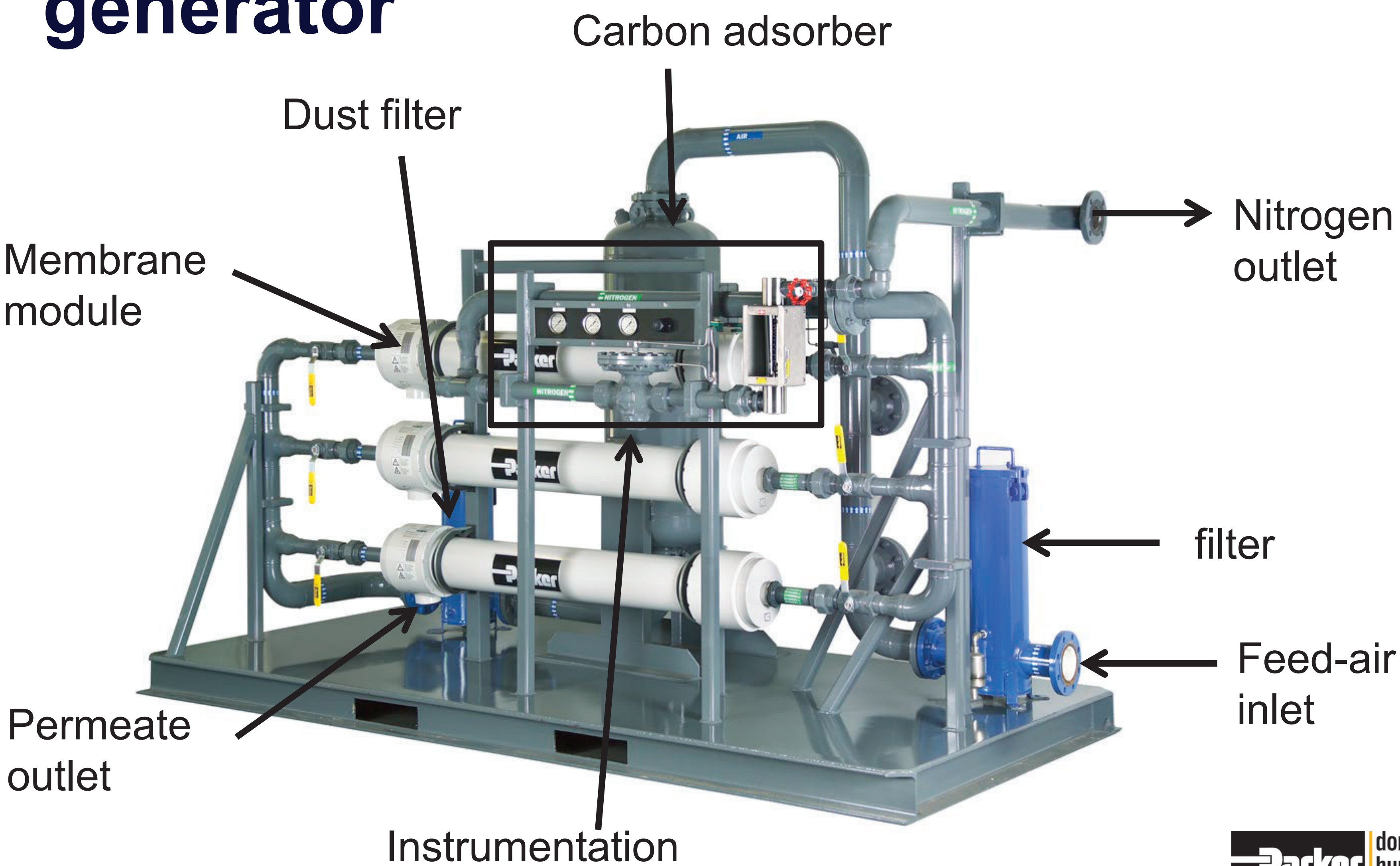
Use of membrane modules

MEMBRANE MODULE BASED GENERATOR

General layout (typical)



Example N_2 membrane based generator



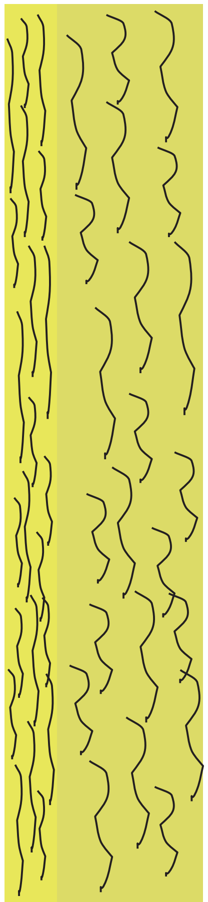
Other examples N_2 membrane based generator

Generator consideration

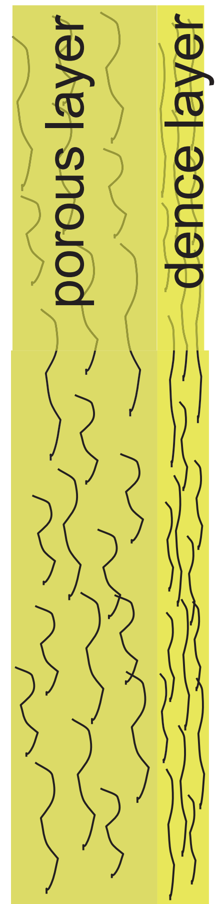
Protect membranes for long lifetime expectancy

- Supply correct feed/air quality
  - Residual oil content: <0.01 mg/m3
  - Particles: filtered at 0.01 µm cut off
  - Relative humidity: < 100% (non condensing)
  - Air quality: clean air free of solvents, hydrocarbons, ozone etc.
- Mechanical damage
  - Over pressure
  - Number of pressure cycles
  - Pressure build up per cycle, advise max 4 bar/sec

Membrane fail mechanisms



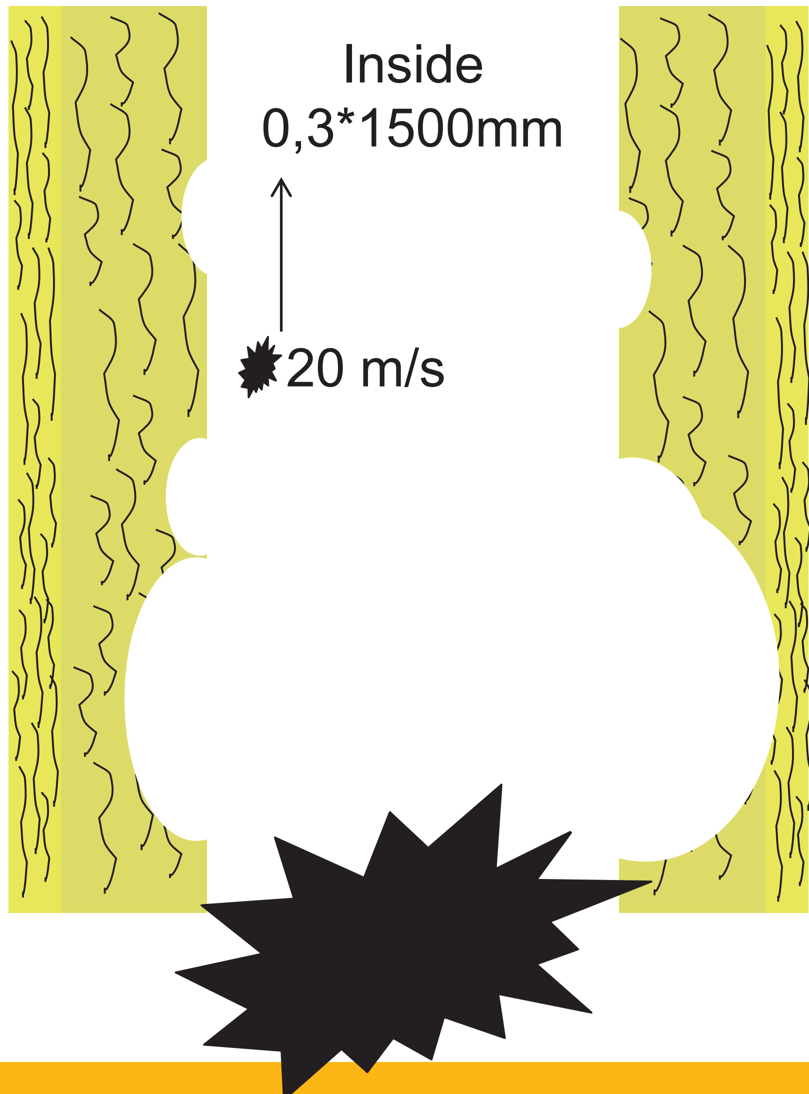
Inside
0,3*1500mm



Membrane failures can be caused by:

- Particles
- Droplets
- Oil Vapour
- Chemicals
- Agresive components

Membrane fail mechanisms



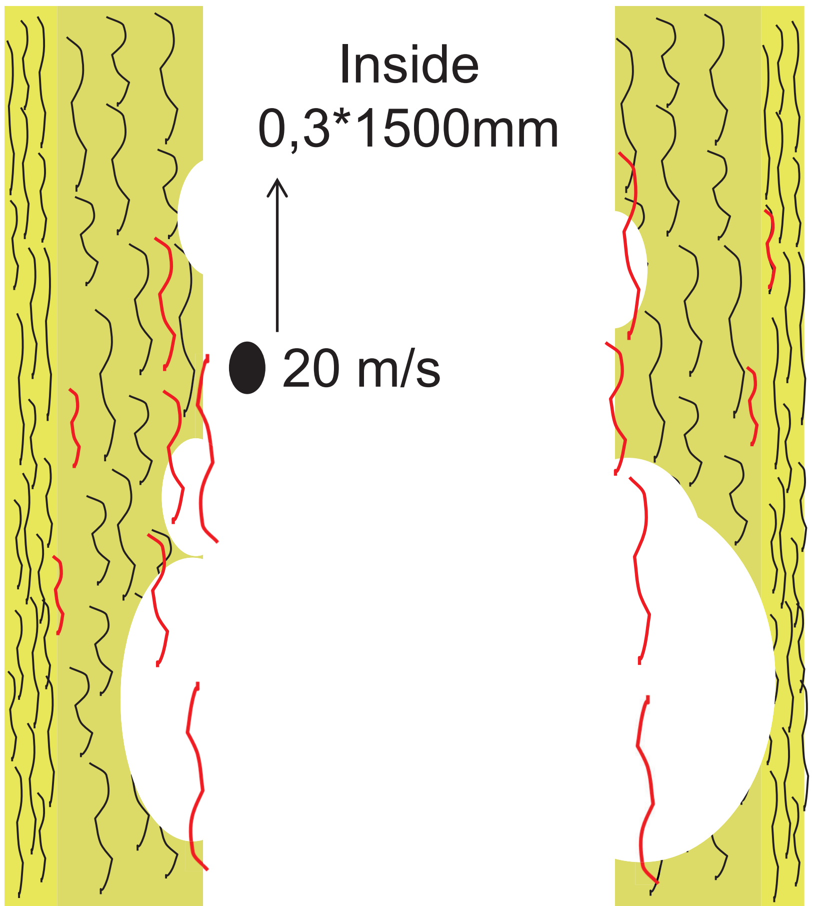
Particles:

Can block the fibre:

- Nitrogen production goes down

- Cause mechanical damage:
  - leaking and broken fibers, air consumption goes up

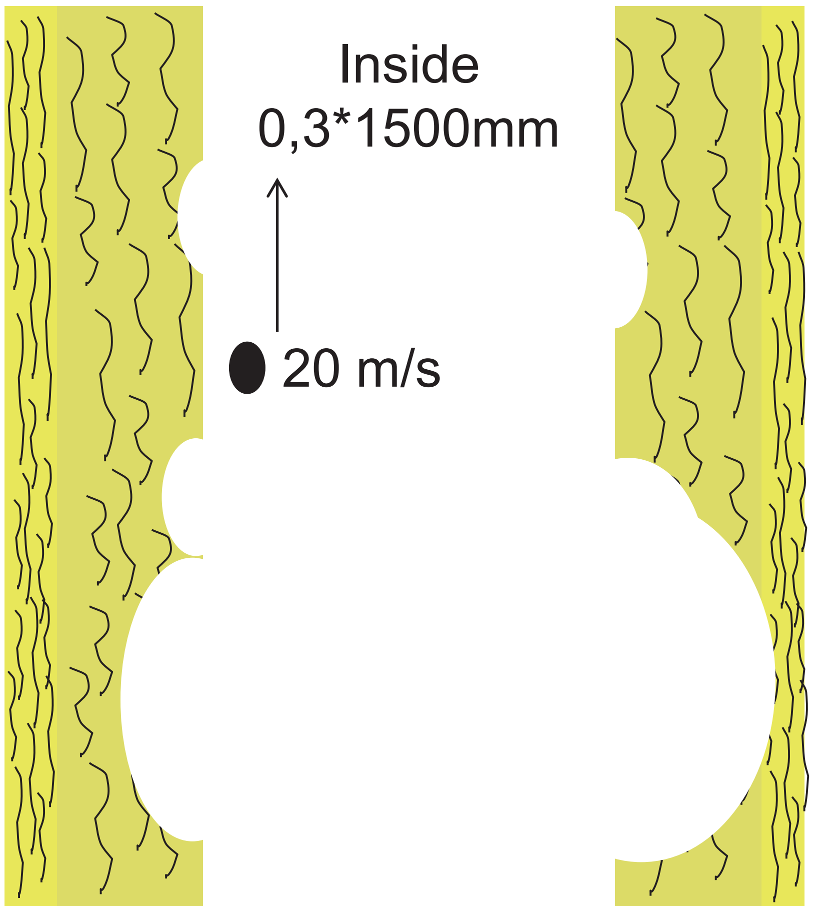
Membrane fail mechanisms



Oil Droplets:

- Cause mechanical damage:
  - leaking and broken fibers, air consumption goes up
- Seal off the membrane
  - Nitrogen production goes down
- Mineral oil can chemically break down the fibers
  - Nitrogen production goes down
  - air consumption goes up

Membrane fail mechanisms

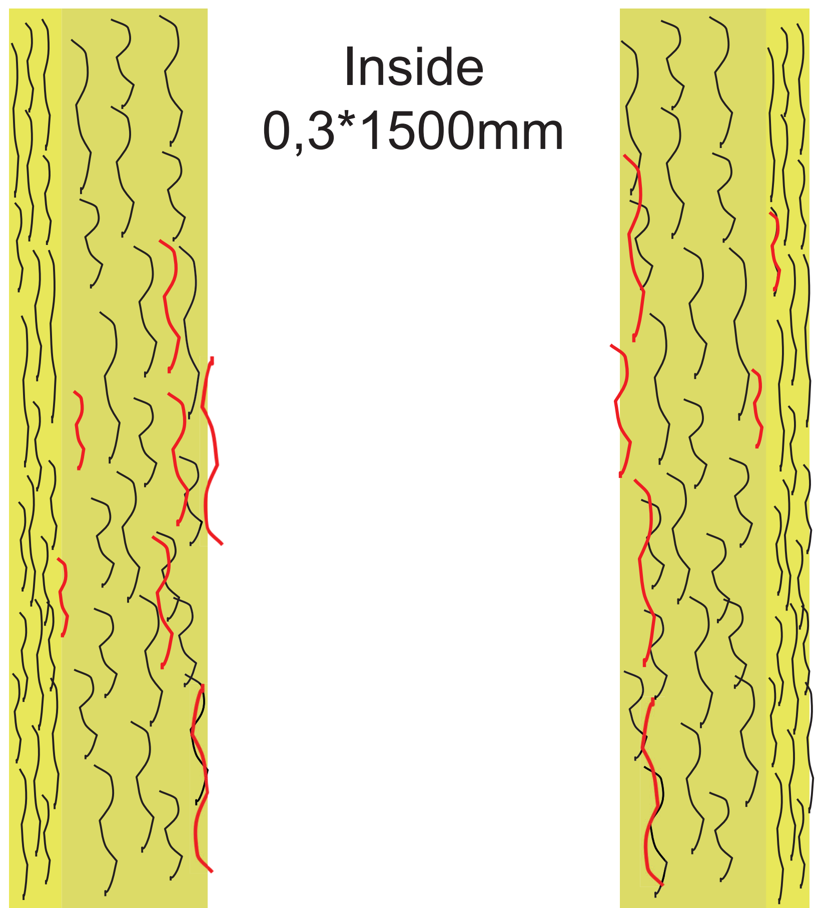


Water Droplets:

- Cause mechanical damage:
  - leaking and broken fibers, air consumption goes up

Note:
Water vapours are not damaging the membrane, water vapour will be permeated
Any condenstation will act as droplets

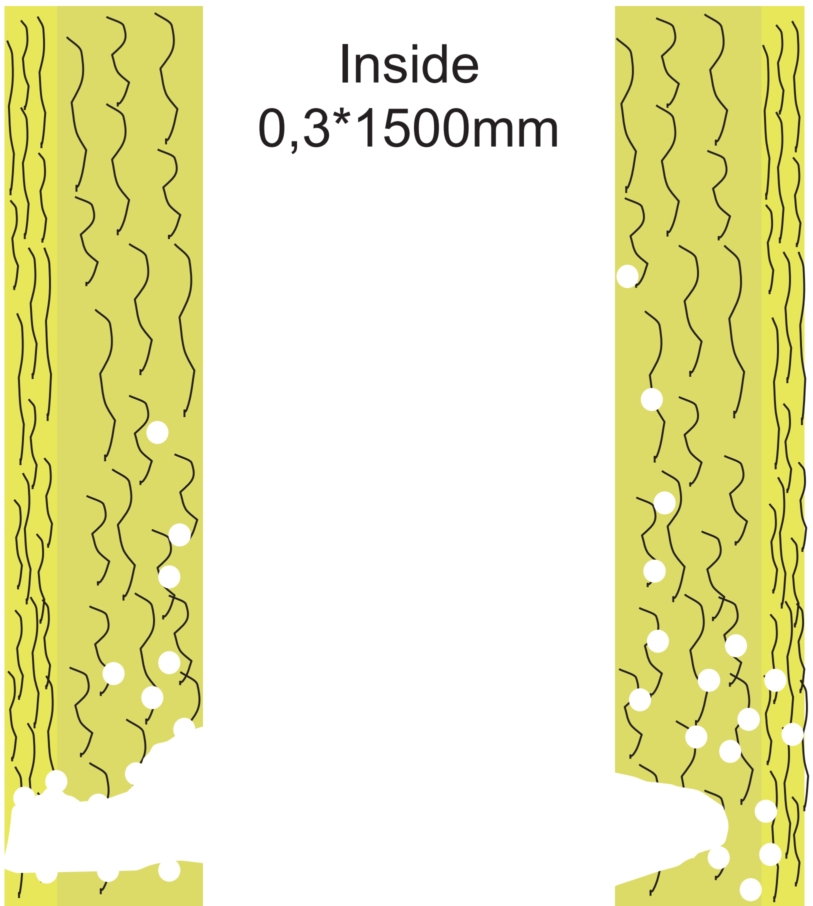
Membrane fail mechanisms



Oil vapour:

- Seal off the membrane
  - Nitrogen production goes down
- Mineral oil can chemically break down the fibers
  - Nitrogen production goes down
  - air consumption goes up

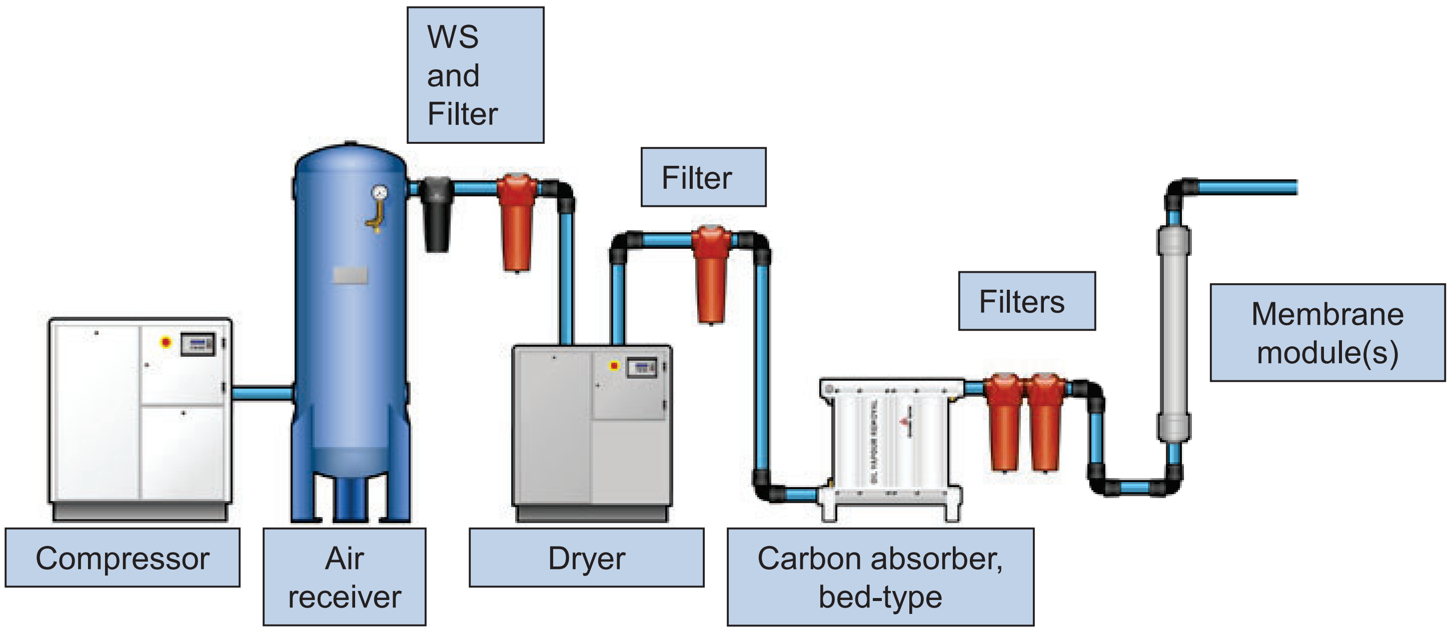
Membrane fail mechanisms



Chemicals,
Agresive components
Ozone

- Chemical degradation of the polymer can break down the fibers
  - Nitrogen production goes down
  - air consumption goes up

Pre-treatment, a possible lay-out

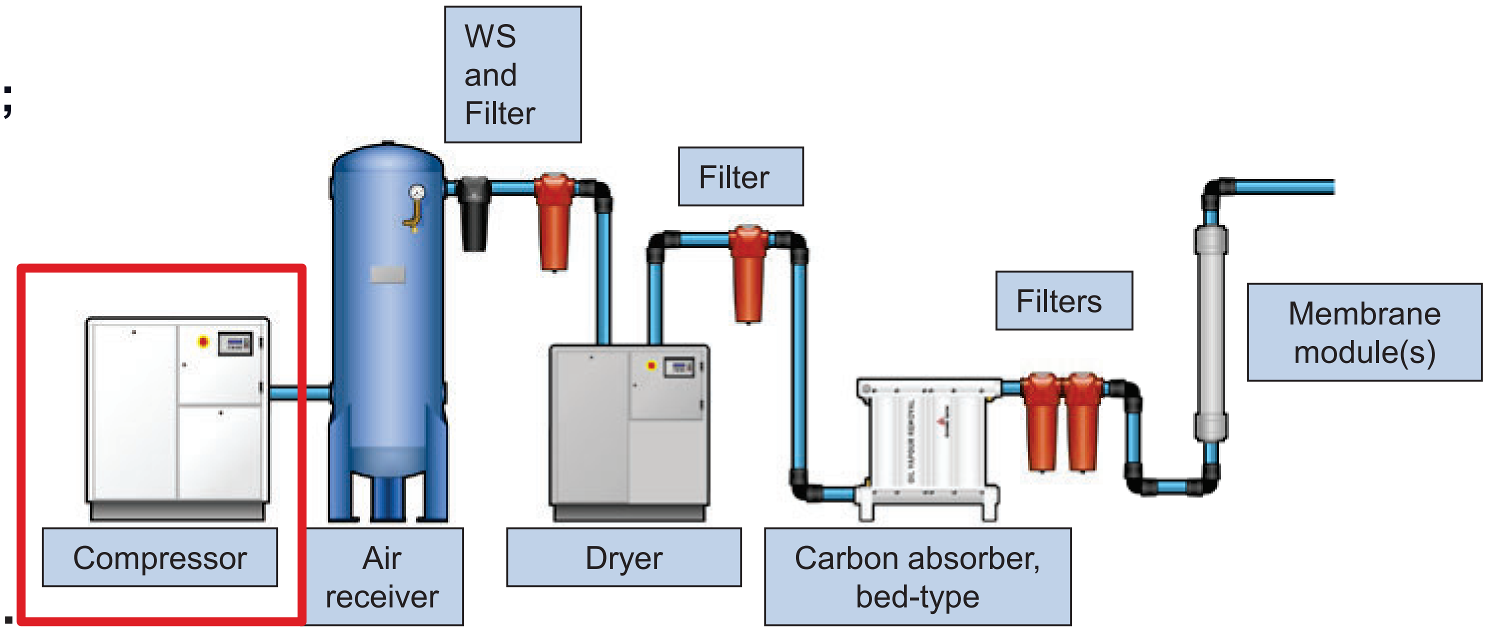


Membrane Feed Air specification

To ensure a long life for Parker membranes modules, feed-air needs to comply with the following;

- Residual **oil aerosols and vapour** content: <0.01 mg/m3
- Particles: filtered at 0.01 µm cut off
- Relative humidity: < 100% (non condensing)
- Air quality: clean air treated by an active carbon bed absorber to remove solvents, hydrocarbons, Ozone etc..

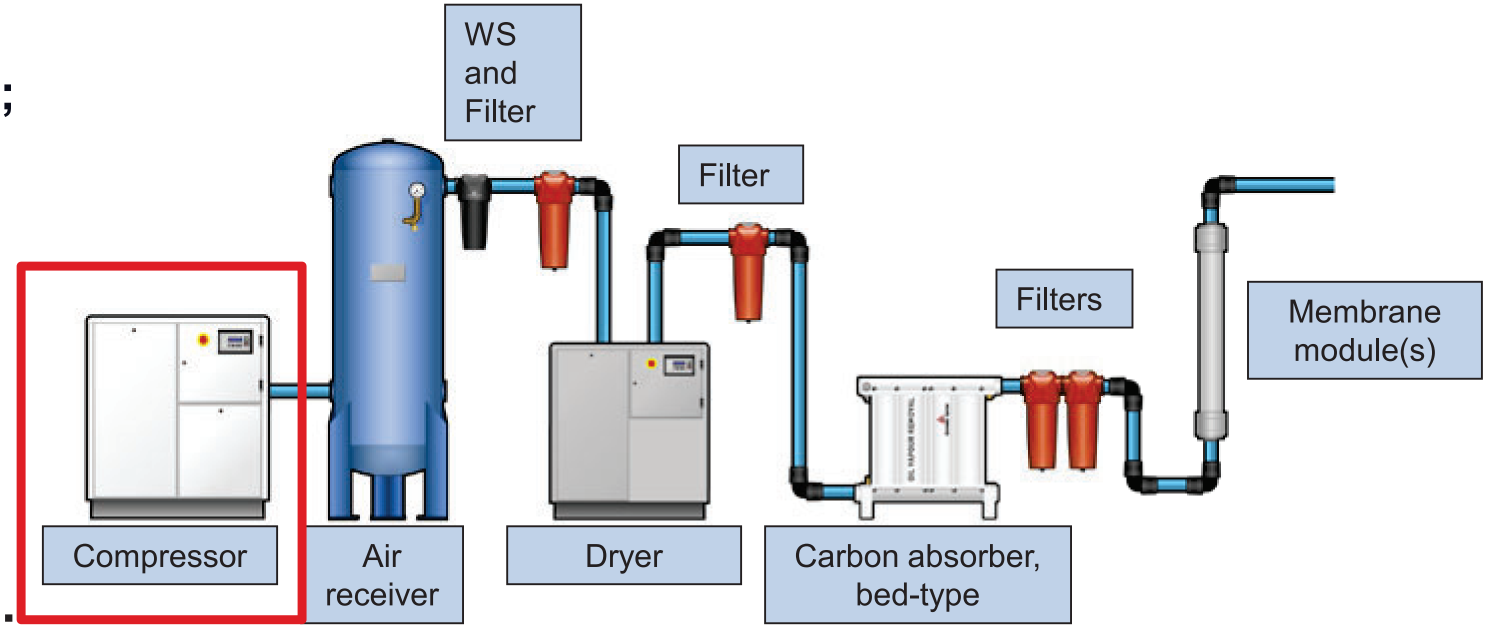
Compressors;



Explanation;

- The compressor can be an oil lubricated compressor or an oil free compressor.
- When an oil lubricated compressor is used, ozone is catched by the oil. To catch oil vapours, an active carbon absorber is required.
- When a oil-free compressor is used, ozone goes through all filters. In that case, an active carbon absorber is required. An active carbon filter is not sufficient!! And remember that oil vapour can enter the system from ambient air!

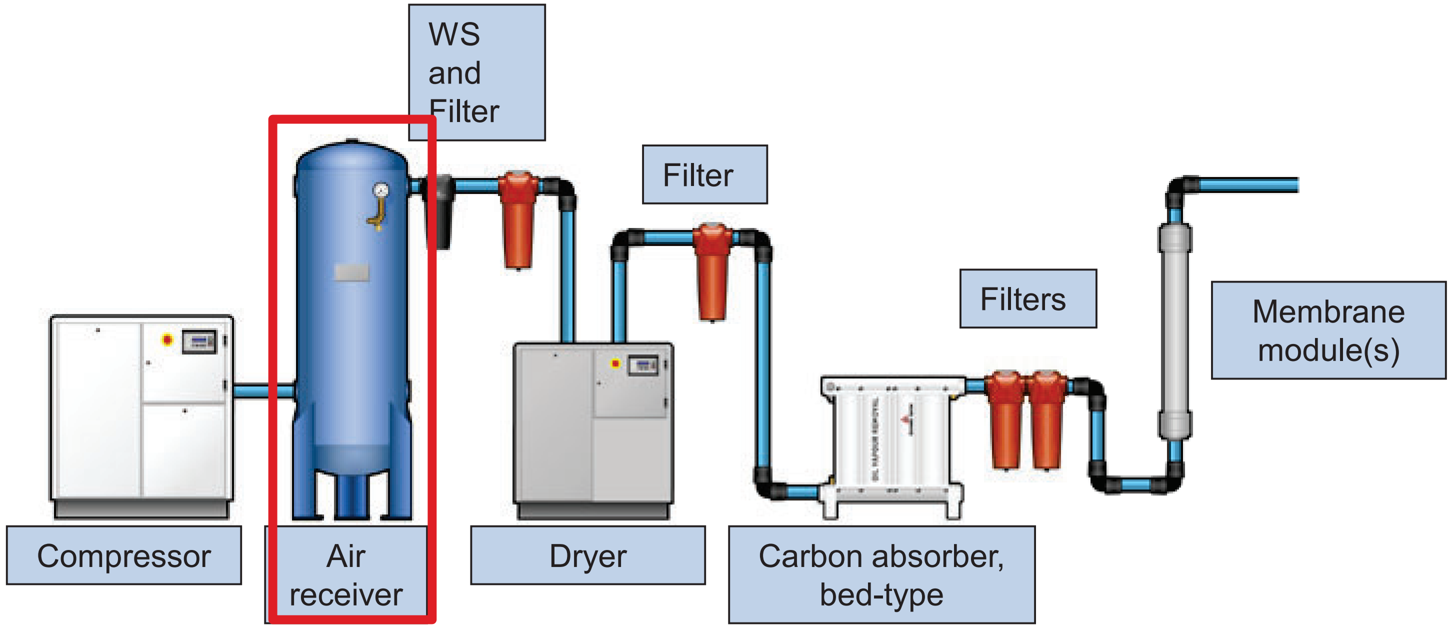
Compressors;



Explanation;

- It is recommended to size the internal compressor-after-cooler in such a way to achieve the lowest outlet temperature. This to reduce the water and oil content to its maximum extent and to achieve the lowest possible permeation rate of the membrane.
- The generator layout shall be designed in such a way that when an oil lubricator compressor is used, the compressor does not switch on and off all the time. Otherwise more oil carry over!

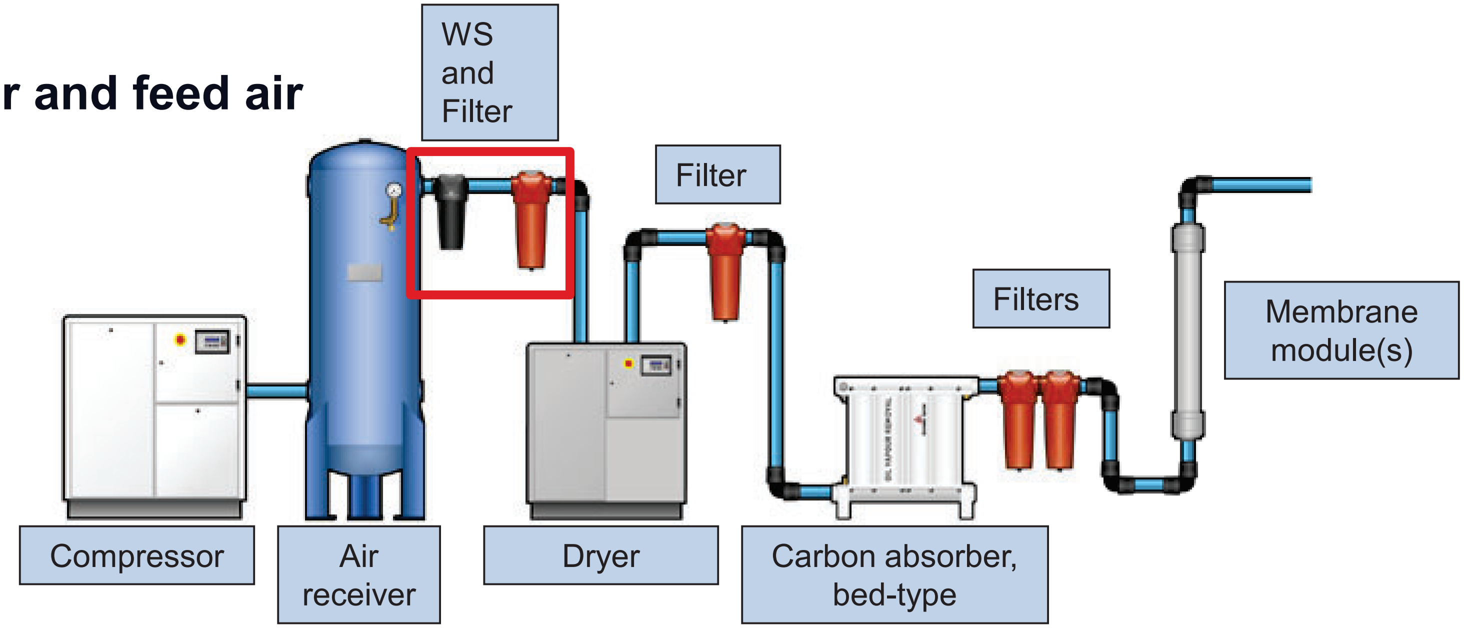
Air receiver;



Explanation;

- The Air receiver or more frequently named as <u>wet air receiver</u> is sometimes used to dampen on/off switching of the compressor. This has as advantage that less oil is carried over from the compressor and less wear and tear of compressor
- It also can help to cool down the air (unless it is placed in direct sunlight)

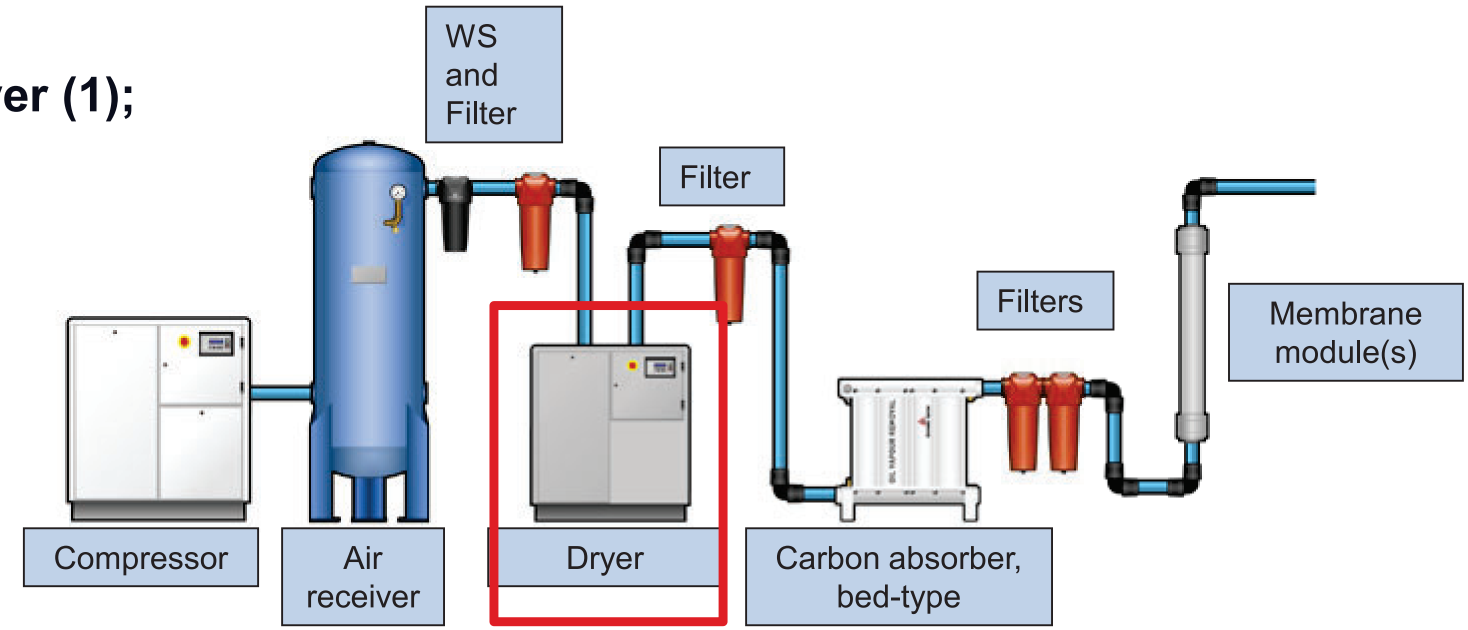
Water separator and feed air filters (1);



Explanation;

- Water separator is recommended when it is unsure whether liquid water can be carried over. The downstream coalescing filters are not designed to remove bulk water. In case that pipework between air receiver - dryer is short and pipework is indoors a WS can be void.
- A coarse coalescing filter (AO) which removes 1 micron particles, water aerosols and oil aerosols. This to protect the heatexchanger in the refrigerant dryer against heavy oil fouling. The heatexchanger is difficult to clean out.

Refrigerant dryer (1);



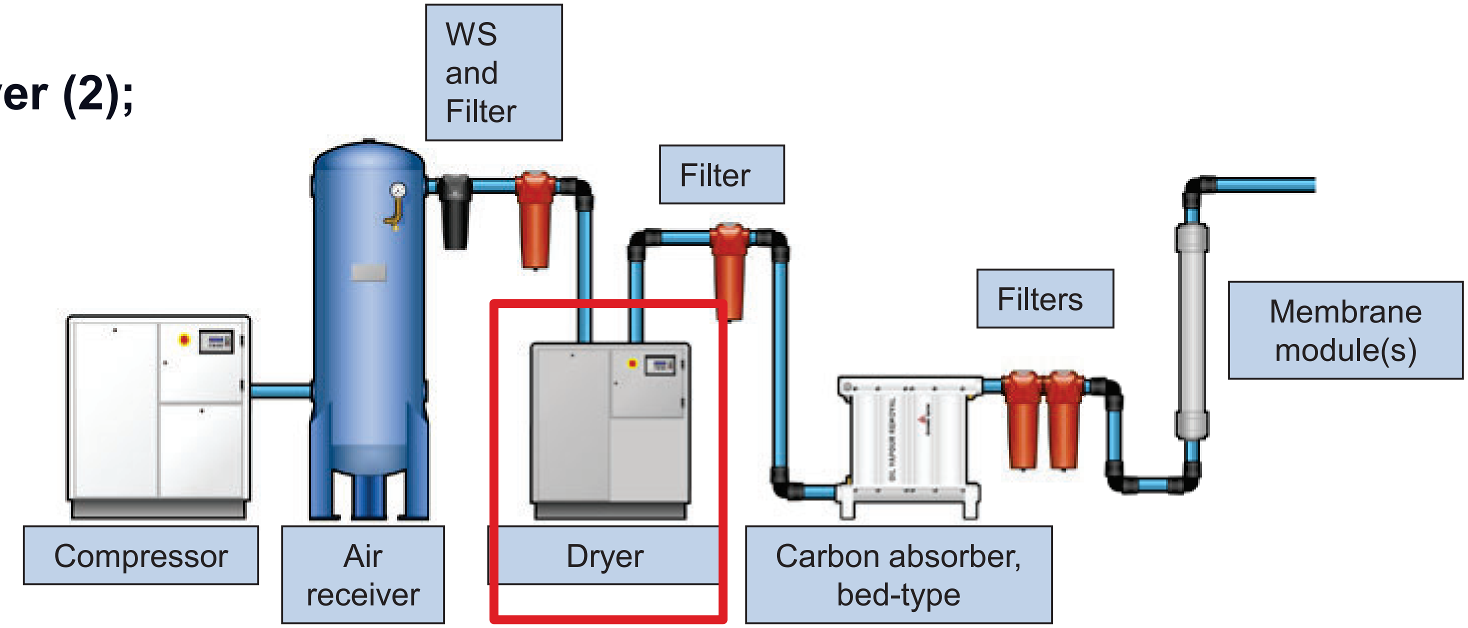
Explanation;

- The use of a refrigerant dryer combines four advantages;

  (1) The air is dried to a pressure dewpoint of +3 degC. After drying, the air is heated up again. The outlet temp. Is in average 7 degC lower as the feed air temp. No condensation can occur in the membrane module.

  (2) Due to a lower temperature, air can also contain less oil. This results in a lower load on the carbon absorber downstream.

Refrigerant dryer (2);



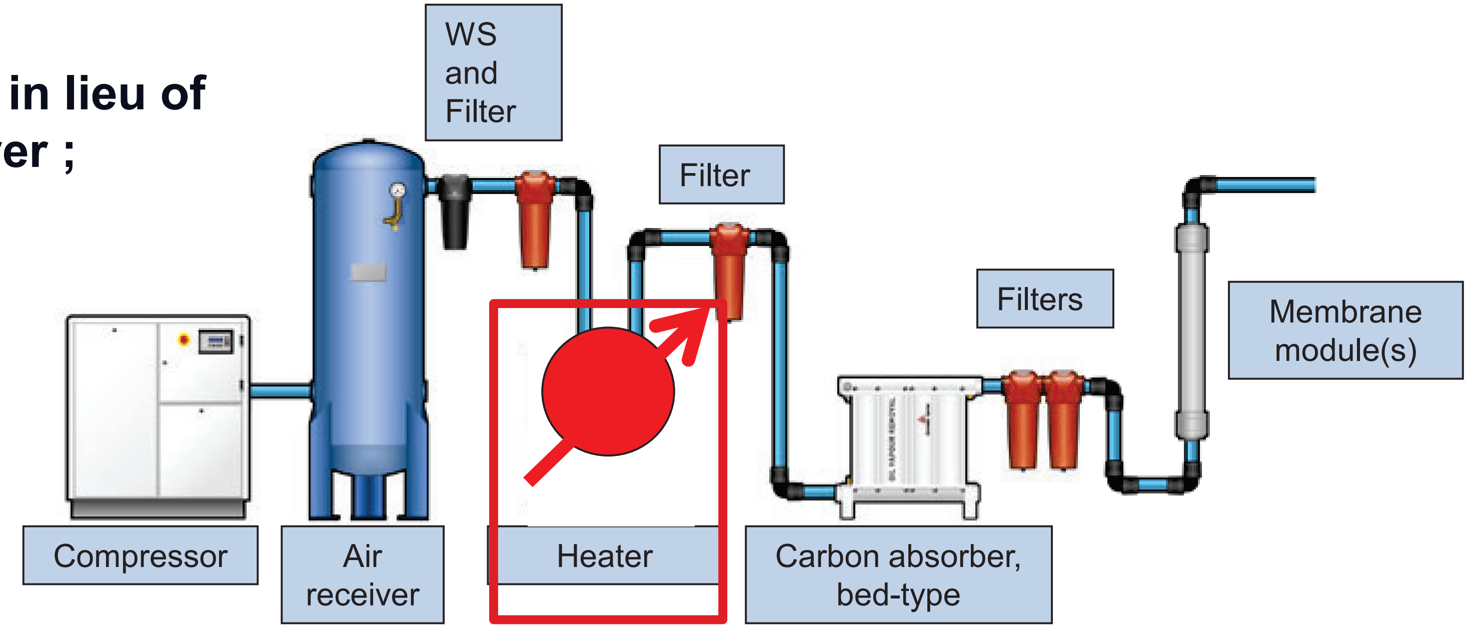
Explanation;

- The use of a refrigerant dryer combines four advantages;

  (3) The feed air temperature to the membrane is lower which results in lower permeation rate

  (4) The lower membrane operating temperature ensures a longer lifetime of the membrane.

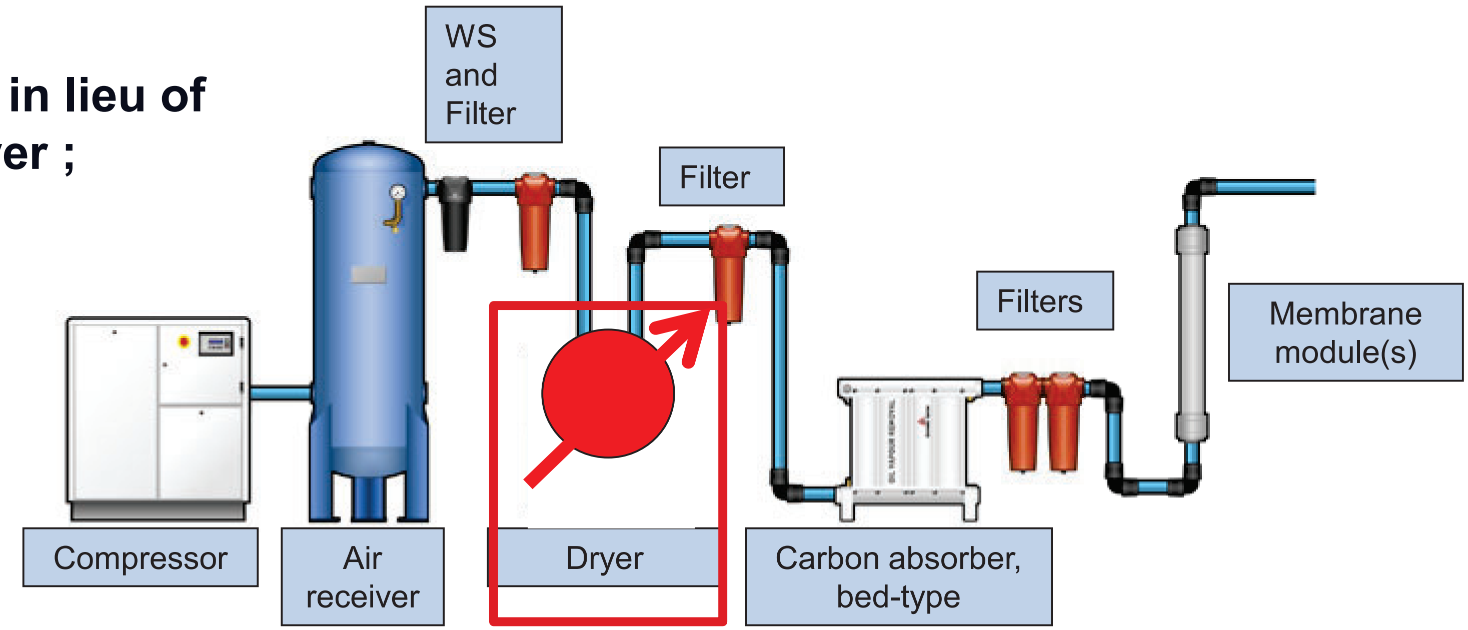
Electric Heater in lieu of Refrigerant dryer ;



Explanation;

- The use of a refrigerant dryer is limited to safe areas. Often, this one can not be used in Hazardous areas which is often the case in Oil&Gas applications.
- In such case it is recommended to utilize an explosion proof heater in lieu of a ref. dryer.
- When a heater is used, it shall be considered that the membrane operating temperature will be higher and as result a higher permeation rate, a higher air consumption which have all impact on sizing of compressor, vessel, filters and piping.

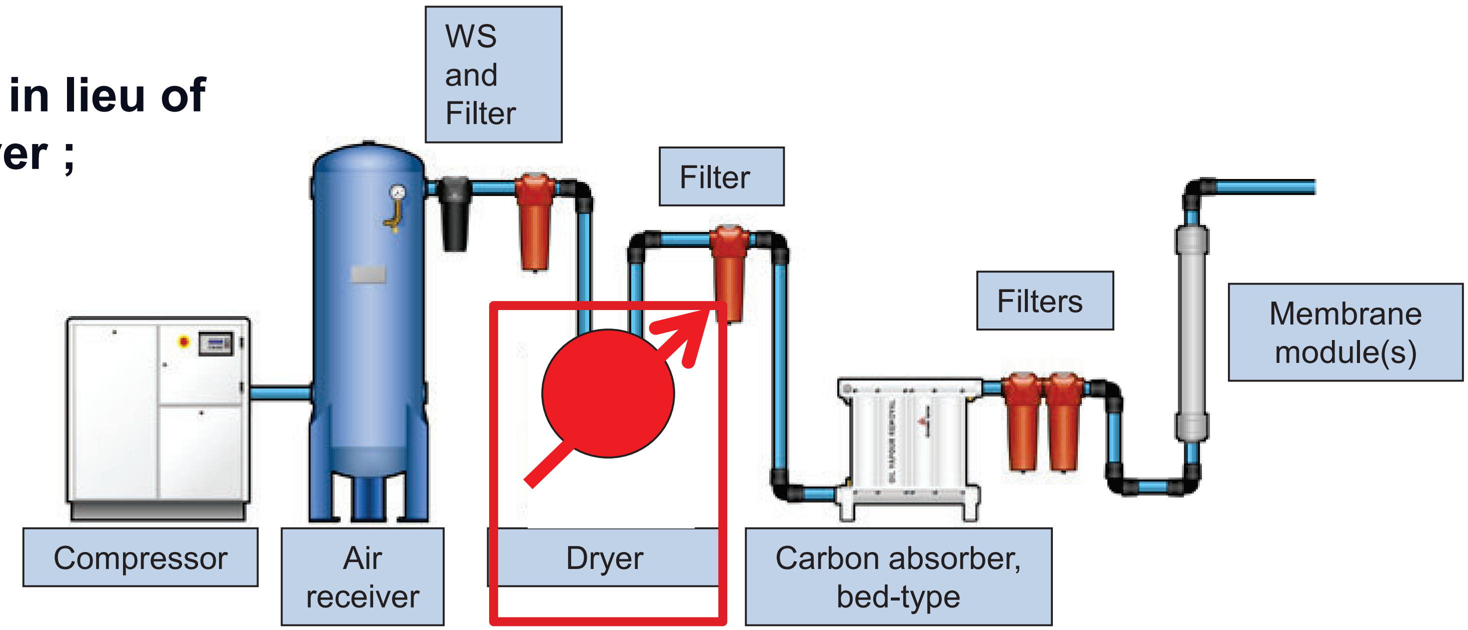
Electric Heater in lieu of Refrigerant dryer ;



Explanation;

- When a heater is used, it is recommended to position it upstream an active carbon absorber to ensure that the active carbon is loaded with less than 100% relative humidity of moisture. This improves efficiency of the active carbon absorber.
- The heater shall be sized in such a way that the membrane feed air temperature is minimum 5 degC above its intrinsic dew point temperature. This depends strongly on the lowest ambient temperature.

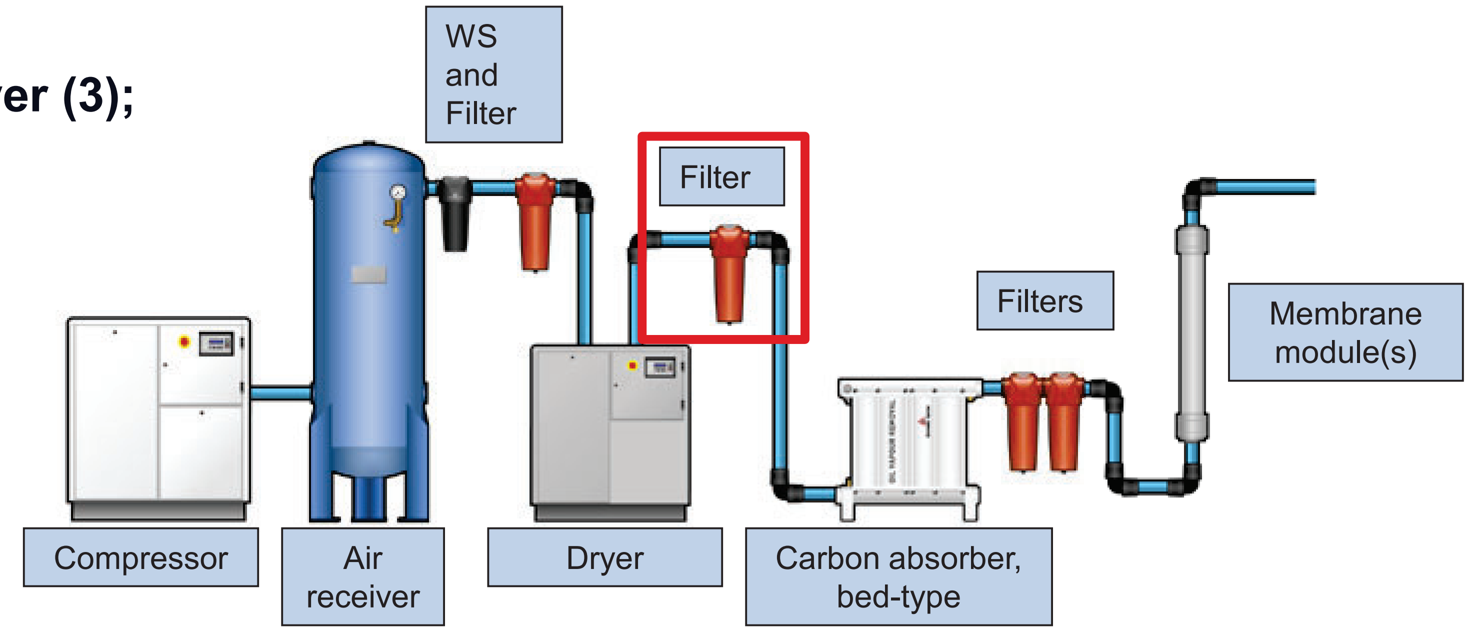
Electric Heater in lieu of Refrigerant dryer ;



Explanation;

- When the piping distance between heater and membrane is kept short, is has hardly time to cool down due to the high air velocity.
- When designing a heater, consider the maximum operating temperature of the membranes which is reflected on the Product Information Sheets.
- When using an electric heater that switches on and off, please consider that overshoot of temperature can occur.

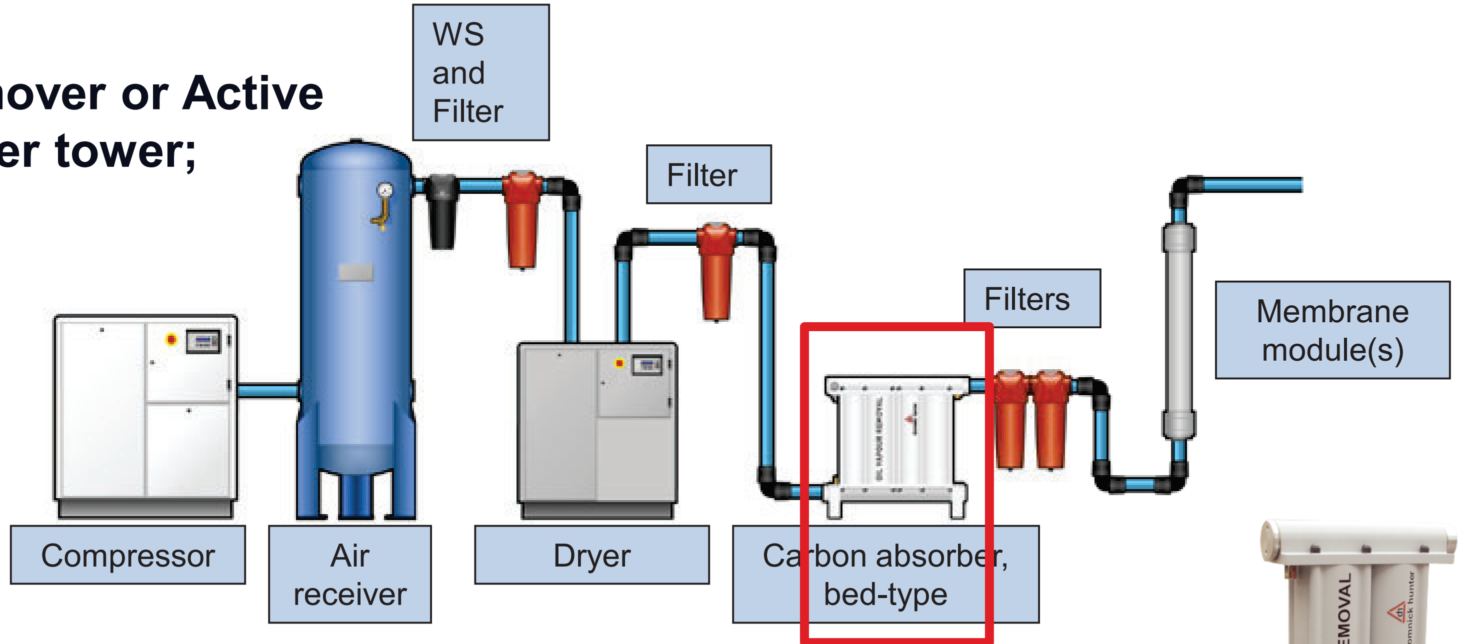
Refrigerant dryer (3);



Explanation;

- A refrigerant dryer can generate aerosols.
- Hence a AA coalescing filter (high efficiency) is required downstream the dryer to protect the active carbon absorber against loading of oil aerosols.
- In case a heater is used in lieu of a refrigerant dryer, this AA coalescing filter can be void. It can be considered to move this filter upstream the electric heater.

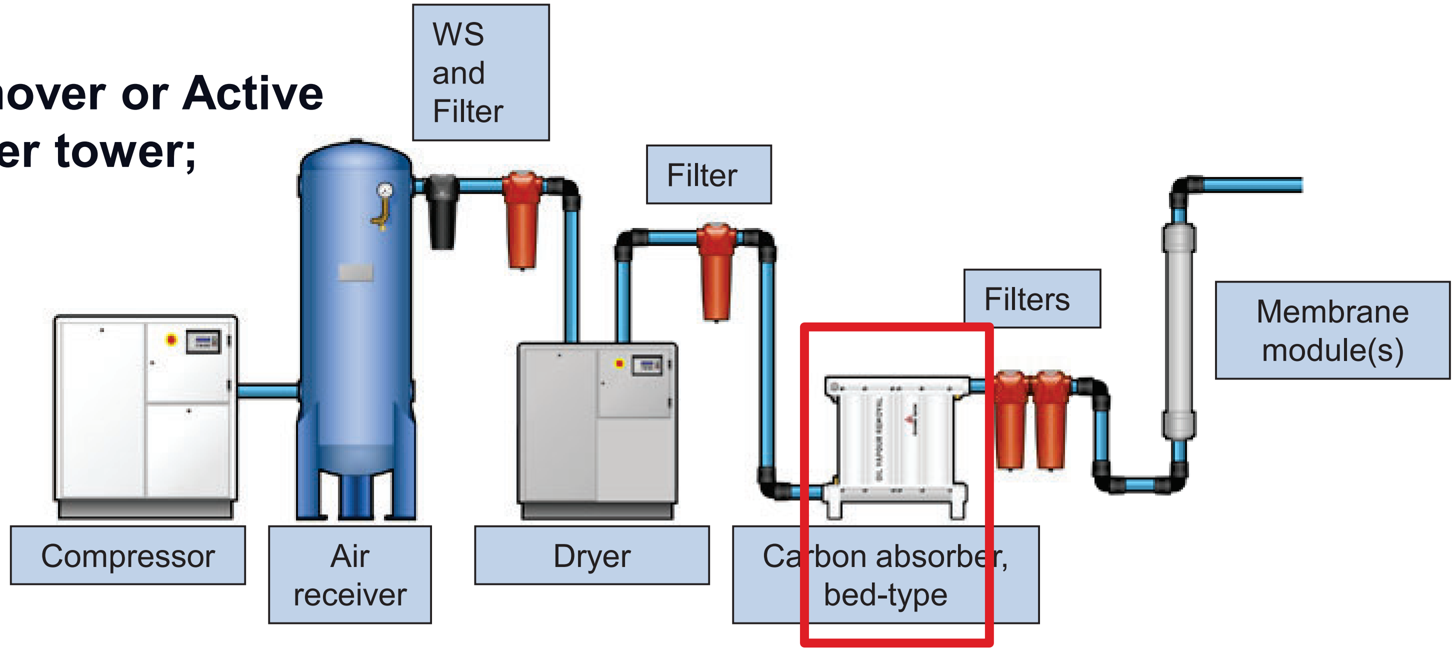
Oil Vapour Remover or Active Carbon Absorber tower;



Explanation;

- Active Carbon is required to remove <u>oil vapour</u> and/or <u>ozone</u>.
- Optimal, an OVR should be used. An OVR is snowstormed filled and creates very little dust.
- An OVR reduces maintenance time when active carbon needs to be replaced.
- When an OVR can not be selected, an active carbon absorber tower shall be installed.

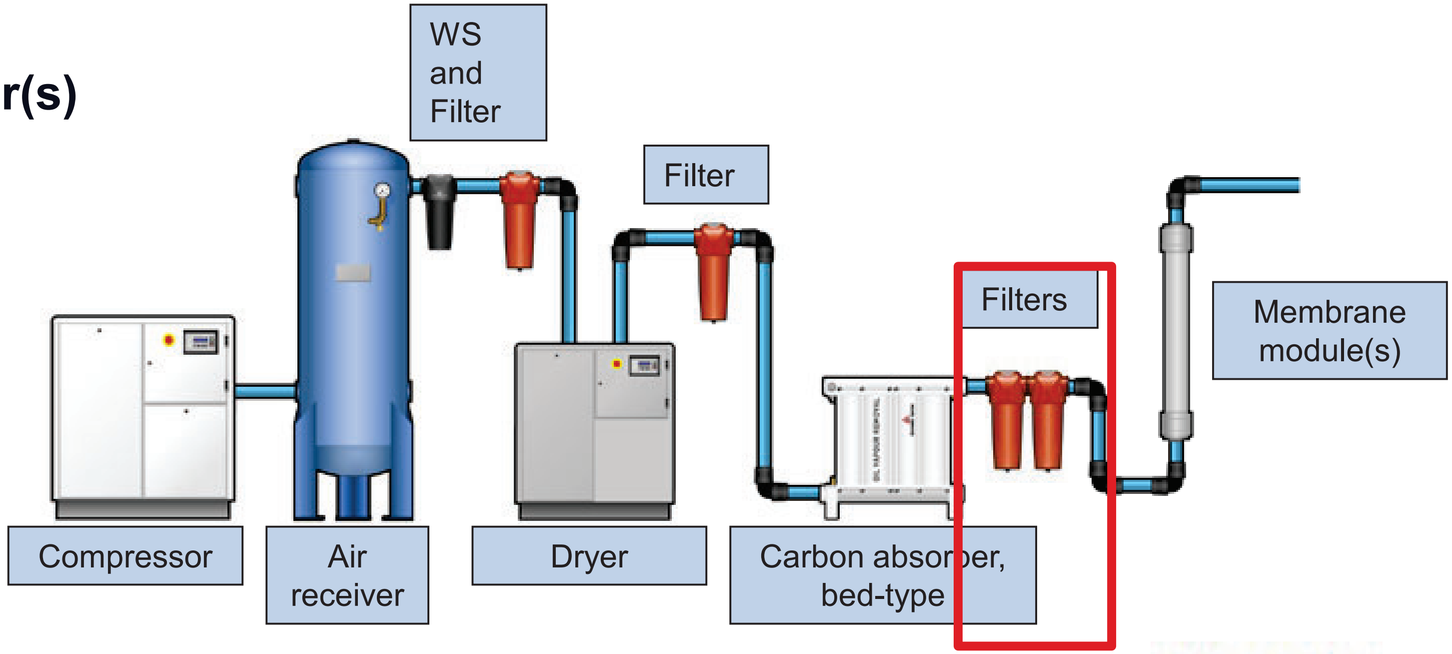
Oil Vapour Remover or Active Carbon Absorber tower;



Explanation;

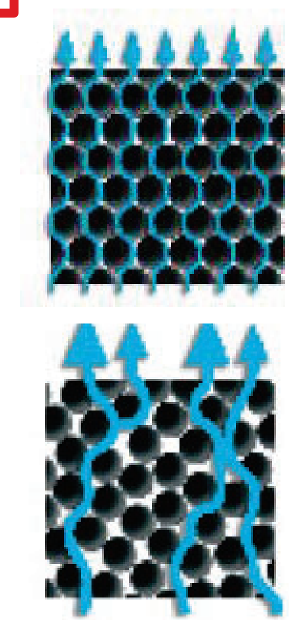
- In general, an active carbon **filter** is **not sufficient** for membrane applications. An active carbon aborber or OVR is required.

Particulate Filter(s)



Explanation;

- To achieve Class 1 dust particles, only an AAR particulate filter is sufficient when an OVR is used.
- When an active carbon tower is used (instead of an OVR), an AR filter needs to be installed upstream the AAR filter. Active carbon absorbers generally generate more active carbon particles.



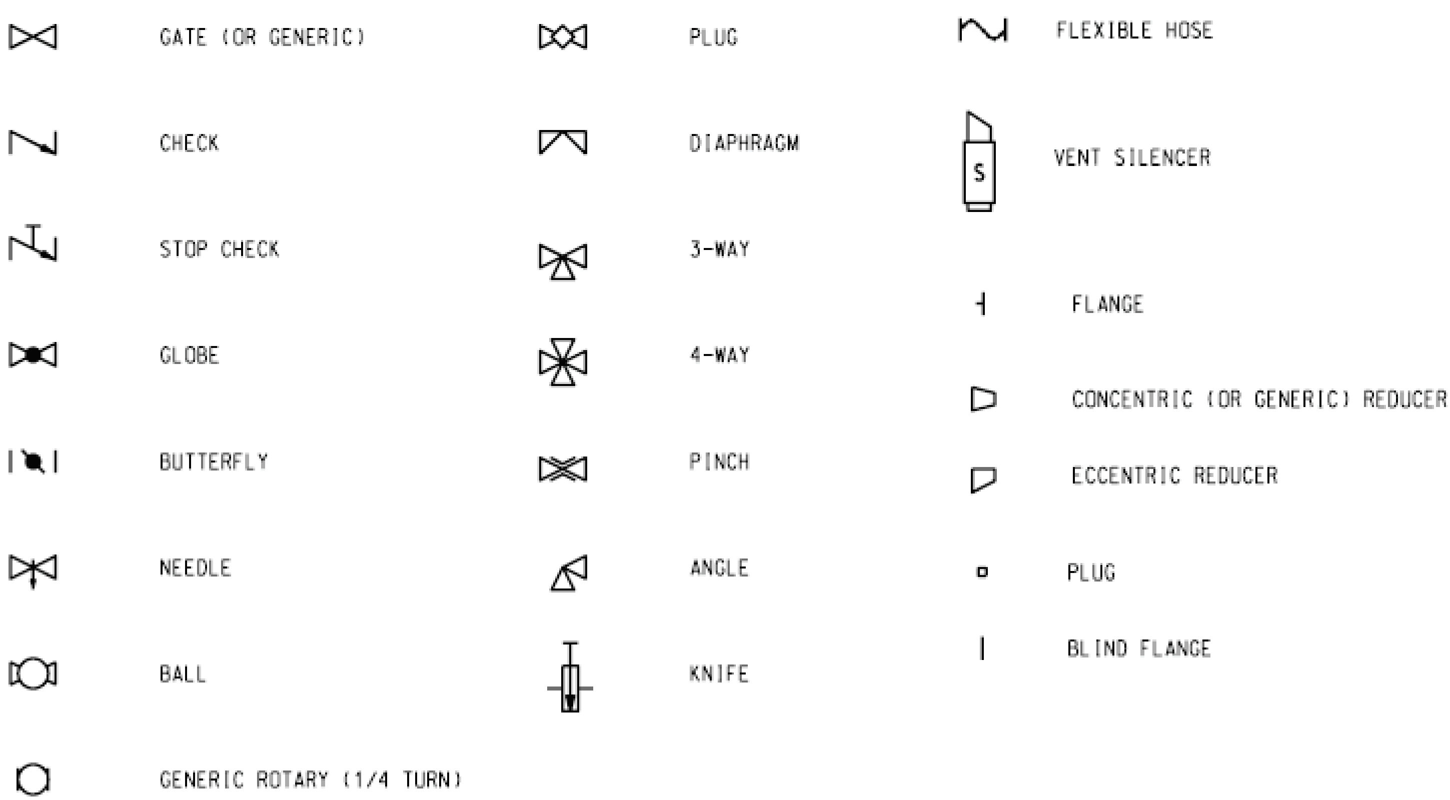
Parker domnick hunter

P&ID

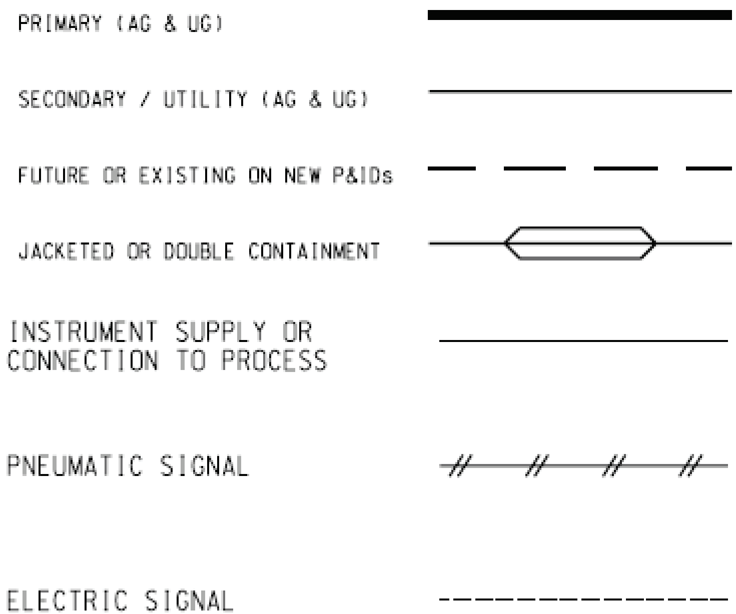
- P&ID stands for Piping and Instrumentation diagram
- Symbols and P&ID as per PIP
  Process Industry Practices
  P&ID
- Instrumentation identification as per

ISA-5.1-1984 (R1992)
Formerly ANSI/ISA-5.1-1984 (R1992)

P&ID Symbols


GATE (OR GENERIC)
CHECK
STOP CHECK
GLOBE
BUTTERFLY
NEEDLE
BALL
GENERIC ROTARY (1/4 TURN)
PLUG
DIAPHRAGM
3-WAY
4-WAY
PINCH
ANGLE
KNIFE
FLEXIBLE HOSE
S
VENT SILENCER
FLANGE
CONCENTRIC (OR GENERIC) REDUCER
ECCENTRIC REDUCER
PLUG
BLIND FLANGE

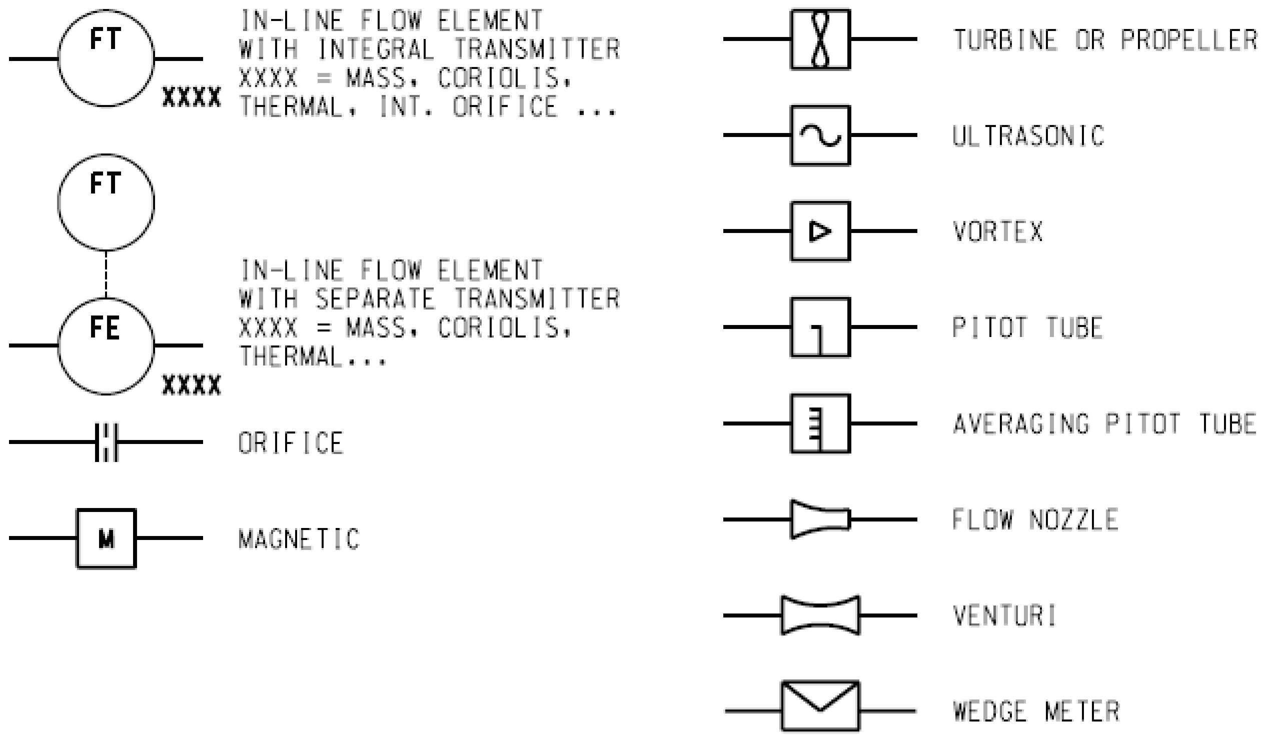
P&ID Symbols


PRIMARY (AG & UG)
SECONDARY / UTILITY (AG & UG)
FUTURE OR EXISTING ON NEW P&IDs
JACKETED OR DOUBLE CONTAINMENT
INSTRUMENT SUPPLY OR
CONNECTION TO PROCESS
PNEUMATIC SIGNAL
ELECTRIC SIGNAL

P&ID Identification Letters

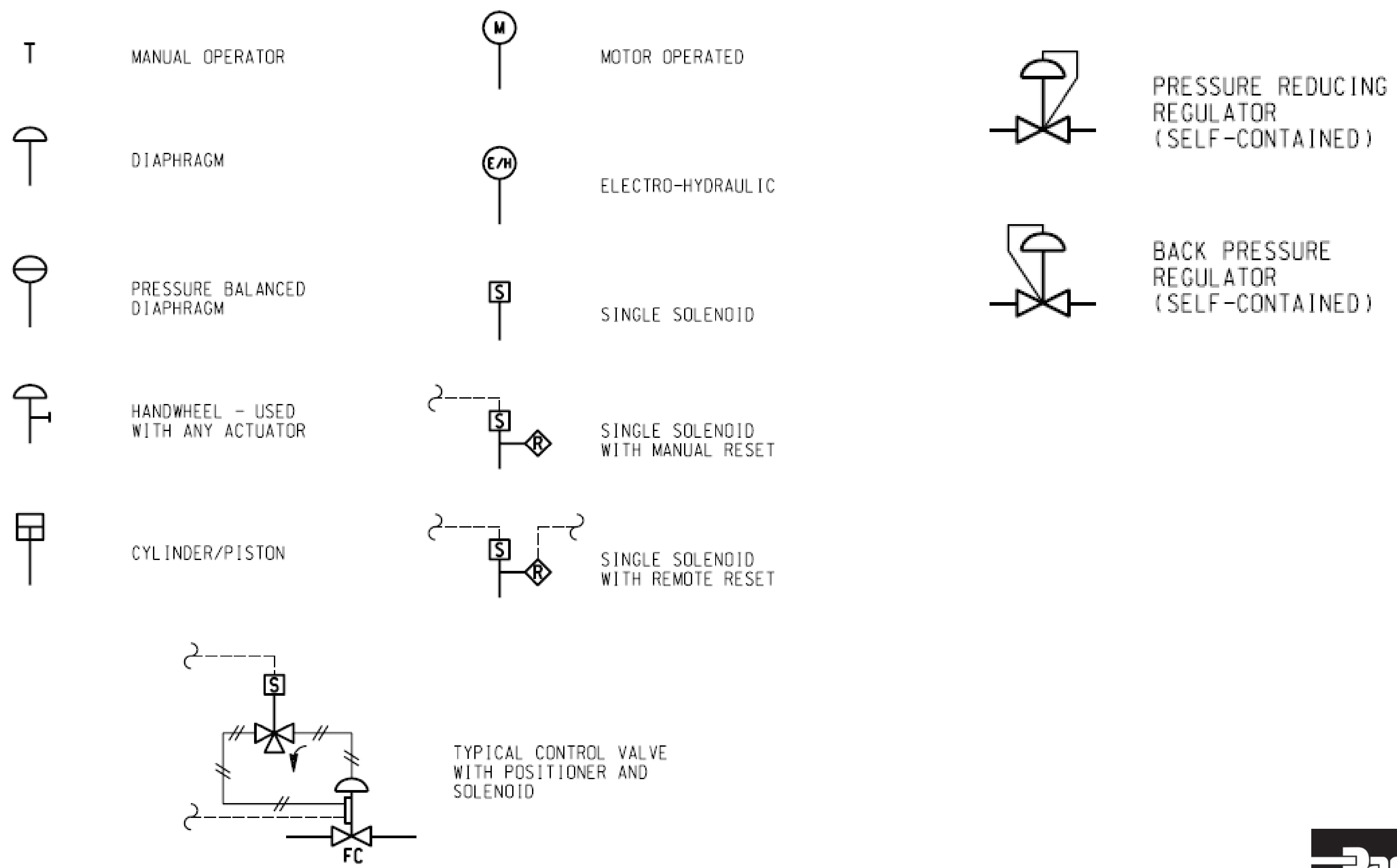
	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, FLAME, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USER'S CHOICE (TYPICALLY CONDUCTIVITY - ELECTRICAL)			CONTROL	CLOSED
D	USER'S CHOICE (TYPICALLY DENSITY OR SPECIFIC GRAVITY)	DIFFERENTIAL			DIVERT
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE OR GAUGING (DIMENSIONAL)		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USER'S CHOICE (TYPICALLY MOISTURE OR HUMIDITY)	MOMENTARY			MIDDLE, INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		OPEN
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY OR HEAT DUTY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	THROUGH
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

P&ID Symbols



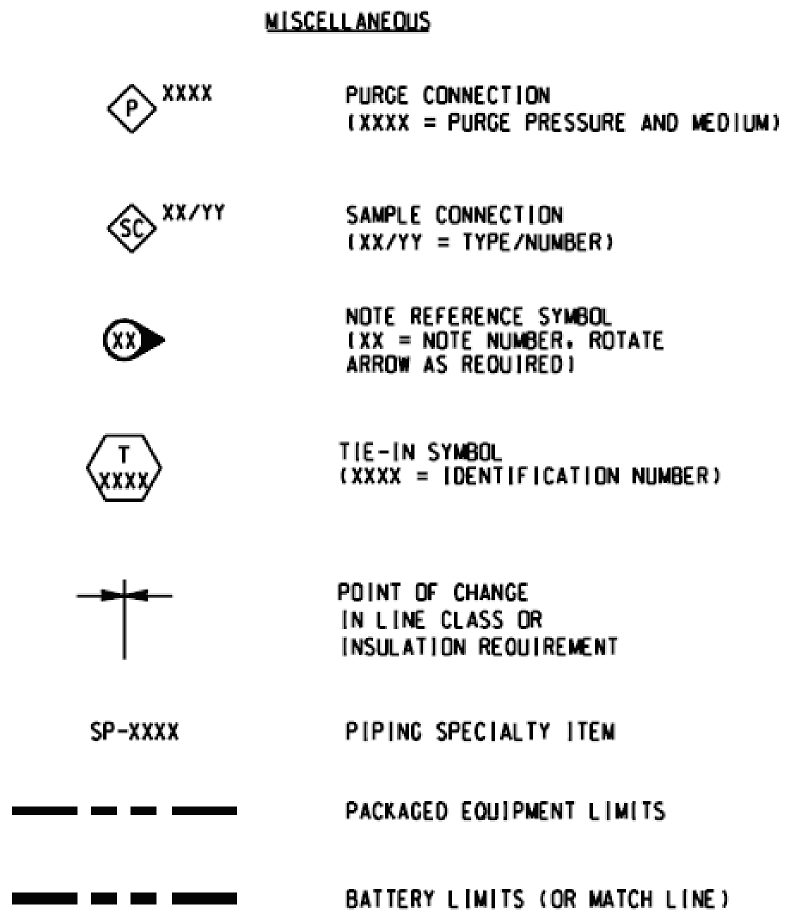
FT
XXXX
IN-LINE FLOW ELEMENT WITH INTEGRAL TRANSMITTER XXXX = MASS, CORIOLIS, THERMAL, INT. ORIFICE ...
FT
FE
XXXX
IN-LINE FLOW ELEMENT WITH SEPARATE TRANSMITTER XXXX = MASS, CORIOLIS, THERMAL...
ORIFICE
M
MAGNETIC
TURBINE OR PROPELLER
ULTRASONIC
VORTEX
PITOT TUBE
AVERAGING PITOT TUBE
FLOW NOZZLE
VENTURI
WEDGE METER

P&ID Symbols



MANUAL OPERATOR
DIAPHRAGM
PRESSURE BALANCED DIAPHRAGM
HANDWHEEL - USED WITH ANY ACTUATOR
CYLINDER/PISTON
M
MOTOR OPERATED
E/H
ELECTRO-HYDRAULIC
S
SINGLE SOLENOID
R
SINGLE SOLENOID WITH MANUAL RESET
SINGLE SOLENOID WITH REMOTE RESET
PRESSURE REDUCING REGULATOR (SELF-CONTAINED)
BACK PRESSURE REGULATOR (SELF-CONTAINED)
FC
TYPICAL CONTROL VALVE WITH POSITIONER AND SOLENOID

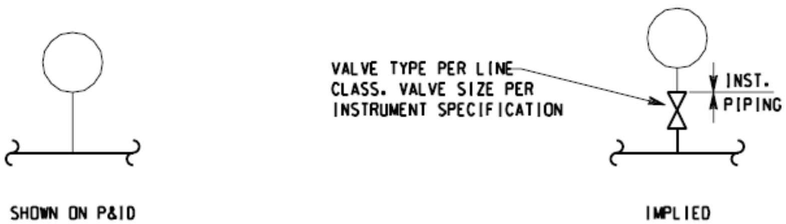
P&ID Symbols


MISCELLANEOUS
P XXXX
PURGE CONNECTION
(XXXX = PURGE PRESSURE AND MEDIUM)
SC XX/YY
SAMPLE CONNECTION
(XX/YY = TYPE/NUMBER)
XX
NOTE REFERENCE SYMBOL
(XX = NOTE NUMBER, ROTATE
ARROW AS REQUIRED)
T XXXX
TIE-IN SYMBOL
(XXXX = IDENTIFICATION NUMBER)
POINT OF CHANGE
IN LINE CLASS OR
INSULATION REQUIREMENT
SP-XXXX
PIPING SPECIALTY ITEM
PACKAGED EQUIPMENT LIMITS
BATTERY LIMITS (OR MATCH LINE)

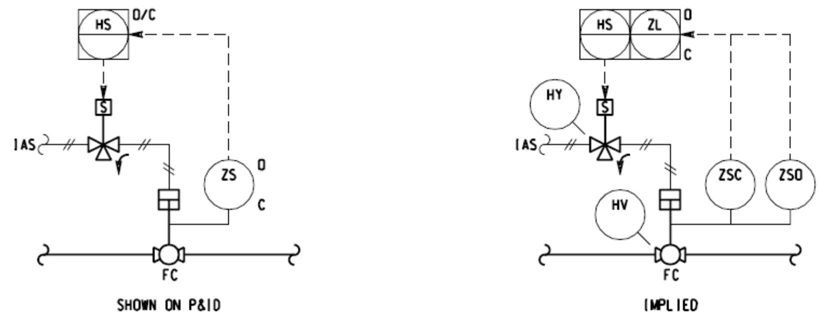
P&ID Symbols

FIELD MOUNTED PRESSURE INSTRUMENT

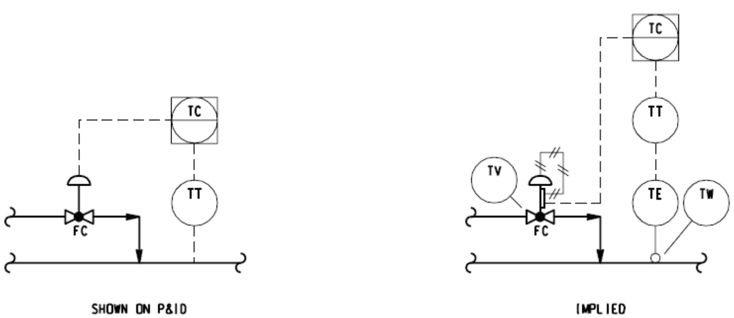
(PI, PT, PS)



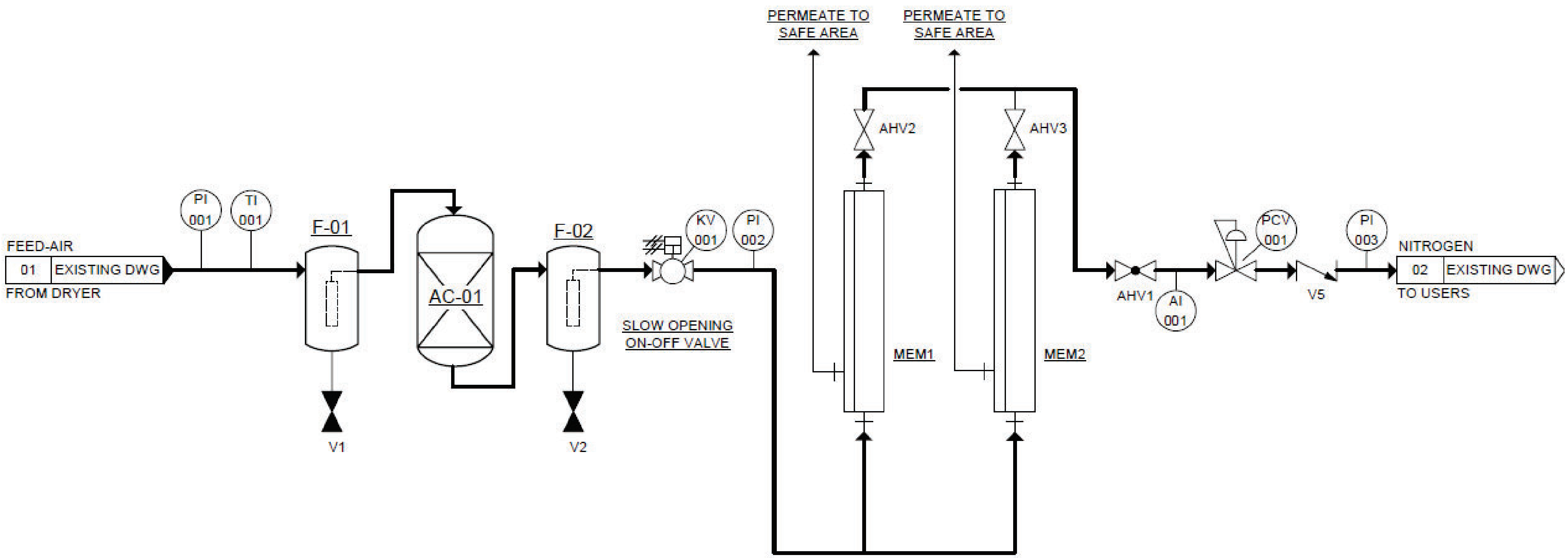
TYPICAL VALVE DETAIL



TYPICAL TEMPERATURE LOOP WITH VALVE POSITIONER



Example P&ID Typical System Layout*



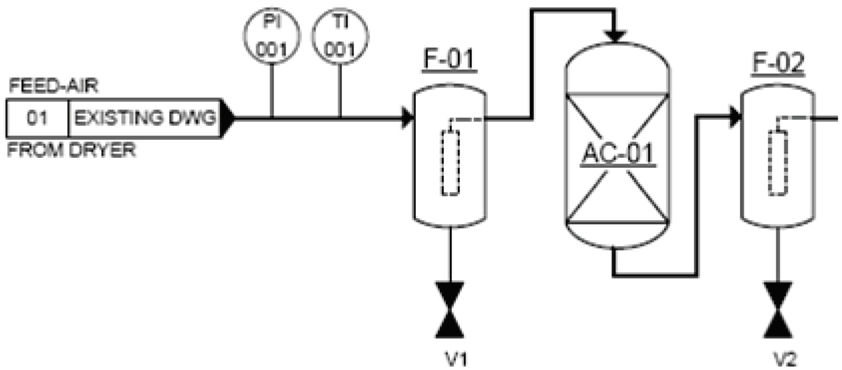
* Configuration with feed-air coming from a dryer

Components

Component List

Tag no.	Description	Type	Function
V1, V2	Manual Drain Valve	Gate vlv (Altern. Ball)	Visual Check for w ater
AHV2, AHV3	Manual Balancing Valves	Gate vlv (or Needle)	Equalize nitrogen purity per membrane module
V5	Check Valve		Prevent back flow from dow nstream
PI-001, PI-002	Pressure Gauge		Pressure Indication
TI-001	Temperature Gauge		Temperature Indication
KV-001	Slow Opening On-Off Valve	Ball Vlv V-Port (Alt. Globe Vlv)	Pressurize Gradually Membrane Modules
AI-001	Oxygen Analyzer		Oxygen indicator
PCV-001	Backpressure Regulator, self contained		Keep membrane pressure constant
AHV1	Hand Valve	Globe vlv (Alt. Gate or Needle)	Hand Valve to set required nitrogen purity
F-01	Coarse Particulate Filter	Coarse Particulate	Retain particulates
AC-01	Active Carbon Absorber	Bed Type, Carbon granulate	Catch hydrocarbon vapours and ozone
F-02	Fine Particulate Filter	Fine Particulate	Retain Fine Particulates
MEM1, MEM 2	Membrane Modules	Hollow Fiber	To generate nitrogen

Pre filtration

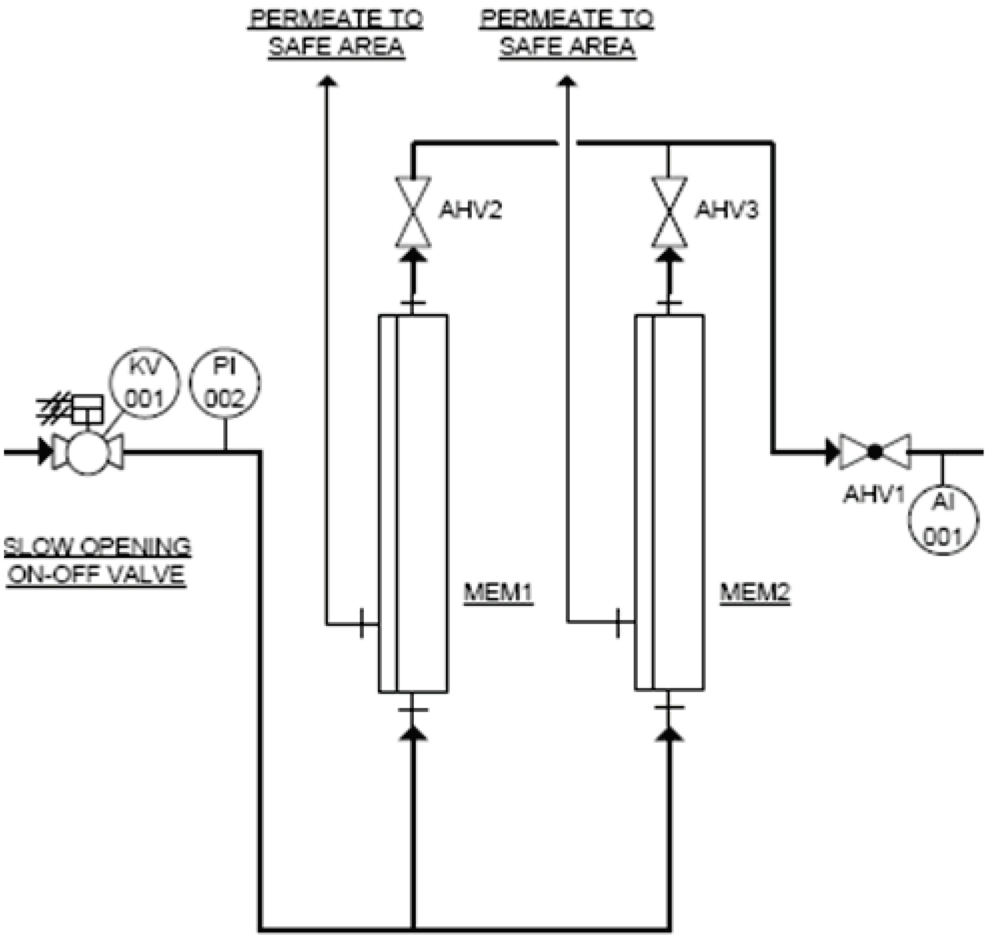


To ensure a long life for Parker membranes modules, feed-air needs to comply with the following specifications:

- Residual oil content: <0.01 mg/m3
- Particles: filtered at 0.01 µm cut off
- Relative humidity: < 100% (non condensing)
- Air quality: clean air free of solvents, hydrocarbons, ozone etc.

- **PI001** inlet pressure monitoring
- **TI001** = temperature monitoring
- **F-01** coarse particulate filter, filtration rate 1 micron particles. F-01 is installed to capture pipe scale.
  Note, in this configuration the feed-air comes from a dryer, which already free of moisture and oil droplets.
- **AC-01** Carbon absorber, bed-type. This can be a vessel or a multi column unit model OVR filled with carbon granulates.
  Note: a carbon filter element is not sufficient!
- **F-02** Dust filter to prevent carbon dust carryover. This can be a fine particulate filter minimum efficiency for 0,01 micron particles
- **V1 & V2** condensate outlet (drain)

Membrane configuration



Modules can be placed in parallel or series (normally only in parallel)

KV001 Automatic Valve (normally closed, slowly opening). In order to prevent the system from pressure peaks a "soft starting" valve shall be selected.

PI002 pressure monitoring showing membrane feed-air pressure

Permeate Waste oxygen enriched air or permeate outlet, vent to atmospheric, prevent dirt, condensation or rain to enter

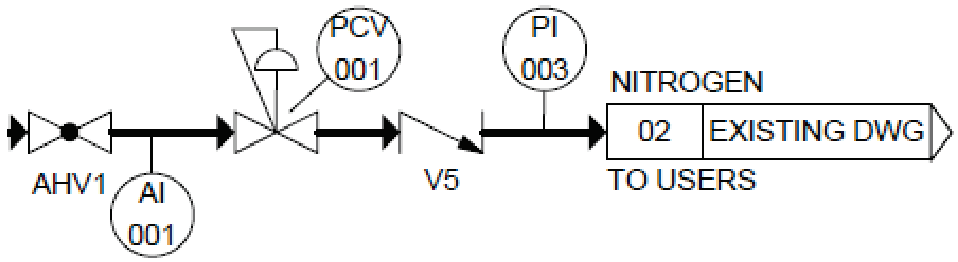
MEM1-MEM2 membrane modules; in this typical example the membrane module sets are put in parallel

AHV2, AHV3 (analyse hand valve) (needle or gate) necessary to balance the performance of individual membrane module sets

AHV1 control valve (needle or gate) for adjusting flow and oxygen content

Isolation valves it is advisable to include isolation valves around every module (manual ball valves). By closing these valves each individual membrane set can be isolated in order to test other sets. Isolation valves are normally not shown on the P&ID

Nitrogen product



- **AI001** oxygen analyser including needle valve. Needle valve used as flow control valve to set a small sample flow feeding the analyser.
- **PCV001** back pressure valve. Necessary in case the nitrogen pressure is higher than atmospheric or in case the nitrogen pressure is continuously changing (delivery to buffer vessel)
- **V5** non-return valve
- **PI003** nitrogen pressure monitoring, this pressure indicator could have a **PSH** pressure switch to isolate the system from feed-air supply if there is no nitrogen consumtion or in case of upset conditions

Parker components in a N_2 membrane based generator

- Nitrogen membrane modules
- Filters
- Dryers (adsorption & refrigerant)
- Coolers
- Chillers
- Tubing's
- Fittings
- Ball valves, slow start valves
- Instrumentation manifolds

Parker Sales Companies can offer all components and equipment to build a nitrogen generator package.

Parker domnick hunter

Questions?