AIR/OIL SEPARATORS

TROUBLE SHOOTING GUIDE

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Air / Oil Separators – Apparent Failures

Air / Oil Separators Used in Rotary Compressors

Apparent Failures

Often one hears "the separator has failed, there is oil carry over from the Compressor!" Careful investigation can reveal that:

- rarely is a "failed" separator due to the separator itself and
- a "failed" separator is the end result, not the cause, in the majority of instances.

1.0 Causes of failures/ apparent failures

1.1 Scavenge line too short

Scavenge line does not reach into internal bowl at the base of the separator.
Result: high oil carry over

1.2 Scavenge line too long

End of scavenge line seats against base of bowl forming a seal. No oil, or an insufficient quantity is sucked up by the scavenge line. Compressor manufacturer's gap clearance is normally 1 to 2 mm alternatively, ensure tapered cut to end of scavenge line.
Result: high oil carry over

1.3 Scavenge line blocked with dirt

Result: high oil carry over

1.4 Scavenge line filter blocked

Some compressor models are fitted wit a small stainless steel mesh filter at some point in the scavenge line which is to be cleaned on a regular basis. If not cleaned the filter will block resulting in no scavenge action.
Result: high oil carry over.

1.5 Scavenge line cracked / damaged

Allows atmospheric air to be ingested and insufficient or no oil removed from separator.
Result: high oil carry over.

1.6 Scavenge line dented

This restricts scavenging action by not allowing a sufficient quantity of oil to be removed.
Result: high oil carry over.

1.7 Scavenge line bent due to mishandling

Be careful not to bend the scavenge line when removing the air / oil separator tank flange and placing it on the floor. A bent scavenge line will not be able to remove oil from the separator.
Result: high oil carry over.

1.8 Scavenge line ferrule at air/oil separator tank flange

If the ferrule does not form a tight seal, air instead of oil will be sucked up by the scavenge line.
Result: high oil carry over

1.9 Scavenge line restricting orifice

Some, not all, compressors have such and orifice installed at some point in the line. It is a small item and in dark compressor rooms when dismantling the scavenge line it can unknowingly be dropped / lost.

1.10 Scavenge line ID

It is not unknown for compressors of the same make and model to have different diameter scavenge lines. Those with a smaller internal diameter will scavenge less oil than those with a larger internal diameter.
Result: higher oil carry over.

1.11 Multi scavenge line

Some compressor models have two scavenge lines both with in line small sintered bronze filters. When one filter becomes blocked it is often removed which then creates an imbalance of pressure between the scavenge lines resulting in oil carry over. Note: if the filters are replaced by orifice plates then both orifices must be of the same diameter.
Result: high oil carry over and saturation of separator if scavenge line pressures not equal.

1.12 Scavenge line incorrectly connected

After improper compressor repairs it has been known that the discharge end of the scavenge line was connected to the pressure side of the air-end instead of the suction side. Compounding the error was the fitting of a non-return valve in the scavenge line.
Result: high oil carry over.

1.13 Shellac, dust, dirt or other particles in oil circuit

Typically a compressor air filter has a 25 micron rating, an oil filter 10 micron and an air / oil separator a 3 micron rating. Especially in dirty environments due to the fineness of the separator filter media it becomes a receptacle for particles not captured by the air or oil filter. The separator becomes clogged.
Result: rapid increase in differential pressure can result in separator implosion.

1.14 Storage and handling of new oil

The oil should be stored away from sources of industrial contamination. The dispensing equipment (funnel and containers) must be clean. Partially emptied containers must not become fouled. Contamination of new oil will block the separator.
Result: high differential pressure.

1.15 Foaming oil

Oil that has a tendency to foam or regular compressor oil that foams for some other reason causes excess oil to pass through the separator. Foaming causes the separator to become saturated. A saturated separator also has a higher differential pressure.
Result: high oil carry over and higher differential pressure

1.16 Mixed oils

This occurs often in error and can also occur when changing from one brand to another and not all the original oil is drained. Some compressors have 5 drainage points. Draining only from the air/oil separator tank and oil cooler is definitely not sufficient for models that also have a gear box, a check valve housing and oil stop valve housing drain points. Mixed oils cause foaming (and often worsen damage). Avoid using the same funnel and containers for different oils.
Result: high oil carry over prior to blockage of separator

1.17 Mixed oils of same make

Some compressor manufacturers sell different branded oils for their stationary and mobile compressors. If these are mixed in error, by topping up or other reason, foaming will occur.
Result: high oil carry over.

1.18 Degraded Oil

New oil of the correct type and viscosity is chemically altered by rusted containers and results in foaming.
Result: high carry over and rapid rise in differential pressure.

1.19 Incorrect oil

Can block the separator or pass through the separator in uncontrolled volume.
Result: rapid rise in differential pressure leading to collapsed separator or high oil carry over.

1.20 Compressor over filled with oil

This reduces the distance between the top of the oil level and the bottom of the separator.
Result: high oil carry over.

1.21 Position of oil level indication mark

With some models of compressors it is possible to fit the oil sight glass up side down. In such instances the marking on the sight glass will be at the wrong position and the compressor will be overfilled with oil.
Result: high oil carry over

1.22 Oil level – sight glass

If the full length of the sight glass is filled with oil then the compressor is also overfilled with oil. This is not an unusual occurrence with mobile compressors.
Result: high oil carry over.

1.23 Mobile compressor – angle of operation

All compressors are designed to operate in a horizontal position. Some manufacturers allow an operating angle up to a maximum of 15 degrees. Care is to be taken that the manufacturer's limit is not exceeded. Not only will it have an adverse affect on the life of the diesel engine but there may also be an increase in oil carry over.

1.24 Synthetic oil used in compressors previously running on mineral oil

PAO and other synthetic oils have a cleaning effect on compressors previously using mineral oil (which includes branded specialized screw and vane compressors oils which are mineral based). The cleaning effect of synthetics quickly develops a sludge which blocks both the oil filter and separator. Seek advice as to the flushing procedure, initial and subsequent filter changer interval and so on from the synthetic oil supplier **before** switching oils. For instance, it is probably advisable to change the oil filter at both 100 and 250 hours after first fill with synthetics and then revert to standard change intervals. It may also be advisable not to change the separator when initially filling with synthetic but at 100 or 250 hours as the separator will become blocked anyway. This would save the cost of one separator; providing that the synthetic supplier is satisfied that the residue mineral oil in the separator media will not adversely affect the synthetic fluid.
Result: blocked separator, in sever instances a collapsed separator.

1.25 Use of incorrect synthetic oil

Use in rotary compressors of certain makes of synthetic oil developed for reciprocating compressors caused development of sludge. Generally, oil injected screw compressors use a viscosity grade 46 oil whilst reciprocating and vane compressors generally use viscosity grade 100.
Result: increasing differential pressure leading to blocked separator.

1.26 Use of correct synthetic oil

In one instance an unexplained phenomenon with aging synthetic lubricant. Although perfect in all respects according to regular laboratory tests, blocked separators age exponentially. This case involved an 8000h life lubricant, a sample being lab tested every 1000 h, oil filter changed every 2000 h; initial separator were changed and the separator life with the new lubricant was normal at 4000 h, however, the cycle repeated itself. All separators sourced from the compressor OEM. Later, however, with the end user deliberately trying to conceal information it did become known that the atmosphere was polluted with an undetermined bacteria that had adversely affected mineral oil in adjoining compressors of a different make but with no apparent affect on the synthetic lubricant – or had it? Perhaps there was another unknown exterior factor. The lesson learnt is to be on the look out for the unexpected.

1.27 Oil change interval

The importance of oil change interval can not be over stressed. The compressor manufacturer's recommended change interval is not to be exceeded. In fact, when elevated operating temperatures occur or in dusty and dirty environments or where there are gaseous pollutants; the oil must be changed at shorter intervals than that recommended under clean conditions. For instance, the life of a mineral oil decreases by half when operating at 110 ºC. Vane compressors are particularly severe on oil. Degraded and dirty oil blocks the separator.
Result: high differential pressure and reduced separator life.

1.28 Oil samples

If taken from the oil cooler or separator tank drain hose, then allow 2 to 3 litres to be drained before taking a sample for analysis. The oil in the drain hose does not circulate in the compressor and therefore the analysis reading would be inaccurate. The sample should be taken within 10 minutes of stopping the compressor.
Result: As the separator and oil filter are being blocked by contaminated oil the differential pressure increases.
It is also advisable to analyze new oil deliveries to compare with the suppliers standard specification.

1.29 Operating temperature

Rotary compressors running on synthetic oil operate at a temperature some 10 º C lower than using mineral oil.
The higher the operating temperature the higher the oil carry over.
Result: shorter separator life and higher oil carry over with high operating temperature.

1.30 Condensate in oil system

A build up of condensed water in the compressor lube system contaminates and accelerates oil degradation leading to blockage of the separator. Condensate build up is particularly pronounced in hot and humid coastal areas during compressor part load or no load operation.
Result: increasing differential pressure leading blocked separator.

1.31 Sonic orifice

Fitted on the outlet side of the air / oil separator tank on a few compressor models and under certain circumstances causes an indication of a high differential pressure – even on start up with a new separator.
Result: immediate high differential pressure.

1.32 Splash plate

Depending upon design, some compressor models have splash or drip plates / shields either as an integral part of the separator tank or fitted to the separator. They are not to be removed.
Result: high oil carry over and / or premature failure of separator if splash plate not correctly fitted or omitted.

1.33 Minimum pressure valve setting

In certain compressor models it has been noticed that there is an oil carry over when the compressor is operating at normal working pressure. By raising the minimum pressure valve stetting to approx 5,8 bar eliminates oil carry over.
Result: high oil carry over in certain models with minimum pressure set too low.

1.34 Extended idle / off load periods

This is often apparent with mobile compressors and stationary compressors with long off load periods which causes the separator to become saturated.
Result: high oil carry over for short period when compressor comes on load.

1.35 Extended load periods

In cases where the compressed air consumption is so high that the compressor is unable to maintain it’s normal working pressure, that is the gauge pressure may be in the range of say 3 to 5.5 bar, then after a short time of about 15 min it will be noticed that there is oil carry over. Once the compressor operates at its normal working pressure the oil carry over will cease.
Result: high oil carry over whilst compressor working pressure is too low.

1.36 Vibration / harmonics / oil cavitation – spin-on separators

Noticeable in 37 KW and larger rotary screw compressors utilizing spin-on type air / oil separators is vibration of the separator itself and in severe cases leads to casing rupture. As there are no moving parts in a spin-on separator the cause is extraneous. The latest spin-on separators have been redesigned to accommodate this phenomenon. It has not yet been noticed with rotary vane compressors.

1.37 Air usage applications

Certain applications, such as forge hammers, consume significant volumes of air rapidly but intermittently. This causes the separator to become saturated and may result in separator rupture (and over extended periods, breakage of the minimum pressure valve).
Result: high oil carry over, collapsed or ruptured separator.

1.38 Operational – isolating valves

Creating a quick differential pressure by opening a discharge valve too rapidly may cause a separator to implode and or rupture.
Result: high oil carry over or a major spill if ruptured.

1.39 Operational – stopping compressor

Only shut down a compressor using the stop button on the compressor control panel. This is for most compressors, a 30 second time delayed stop allowing the compressor to first unload and then partly release compressed air pressure in the air / oil separator tank. When a compressor is switched off at the MCB or by using the emergency stop button (if fitted) the separator will flood.
Result: high oil carry over, collapsed or ruptured separator.

1.40 Electrical power failure

This will have the same effect as the described above under Operational – stopping compressor.

1.41 Testing regulating system on off line compressors

Rapidly opening and closing the air discharge valve will lead to saturation (or in the worse case – rupture) of the separator.
Result: high oil carry over.

1.42 Earthing - compulsory

Separators designed to be earthed but not correctly earthed in the field may lead to an internal flash.
Result: burnt out separator, soot (thick grained) in the separator tank and possibly other mechanical damage.

1.43 Earthing – non-obligatory

Some vane compressors as standard have no provision for earthing. No problem is experienced with aluminum housings but flashes can occur in compressors with cast iron housing.
Result: a burnt out separator in a cast iron housing vane compressor can be expected if not earthed. Separators with O-ring sealing are preferable to those with gaskets. More care is required to fit the O-rings correctly to avoid oil carry over.

1.44 Incorrect separator

In instances of expediency an incorrect separator may have been used. For instance, two separators of identical dimensions apart from a protruding scavenge bowl (dome), one being of the correct design for the particular model of compressor the other not. The incorrect design affects the flow characteristics of the air / oil mixture after entering the separator tank and causes the separator element to become saturated with oil.
Result: high oil carry over and high differential pressure.

1.45 Incorrect separator tank

Occasionally a re-built compressor is assembled with an under sized air / oil separator tank.
Result: high oil carry over.

1.46 Measurement of separator differential pressure

This can only be measured when the compressor is on-load.
(There is a nil differential reading on no-load so the condition of the separator can not be determined.)

1.47 Separator life / compressor model

Often a particular separator fits a number of models in a compressor range. Under identical conditions, the separator life is longer in the smaller model than in the larger model. For example, the life of a separator in a GA808 will be longer than that in a GA1408. Likewise, the life will be longer in a ML90 than in a ML150.

1.48 Separator life / compact compressor design

Driven by production costs, space / foot print reduction and in some instances installation of a dryer within the compressor canopy there is a growing tendency of using smaller air / oil separator tanks. This means that physically smaller separators are used in late model compressors than compared to compressors of the same capacity of yesteryear. A separator’s flow capacity is determined by its surface area. At the same air flow a physically smaller separator has a shorter life.
This is being experienced in the field by the compressors manufacturers of certain compact designs.

Result: reduced separator life in “compacts” compared with previous compressor models of same air flow capacity.

1.49 Environmental pollution – ammonia
Some separators are fitted with an outer sock which tends to disintegrate, when subjected to certain pollutants, migrating to block the inner filter media. Similarly, the pollutants may degrade the media layers.
Result: high differential pressure / or high oil carry over.

1.50 Environmental pollution – aggressive / corrosive chemicals
Aggressive chemical vapours taken in by the compressor cause a degradation and breakdown of the filter media.
Result: high oil carry over.

1.51 Environmental pollution – cleaning fluids
Fumes from ammonia and chlorine based fluids used to clean compressor rooms are taken in by the compressor causing degradation of the oil and blockage of the separator
Result: high oil carry over.

1.52 Other instances of explosions / flash fires
In these instances the separator should be destroyed and never reused.
Explosions, to our knowledge, have not occurred in compressors which do not utilize copper and brass components – oil lines, bearing cages and so on. An explosion on start up, normally on a cold morning, is due to an increase in oil viscosity impeding oil flow to the air-end where temperature rises dramatically within a few revolutions of the rotors.
An explosion / flash fire can occur on start up if the discharge air valve is closed and the regulation system is too sluggish to off load the compressor, larger compressors being more prone to this phenomenon.
An explosion / flash fire can also occur during operation with elevated operating temperature due to low oil level or air intake air filter restriction or increase in pressure ratio or faulty oil thermostatic valve.
On some models clogged oil filters can eliminate oil flow to the gear box when the compressor is un-loaded causing a flash fire or worse when the compressor loads.
Result: burnt separator being the result not the cause of the explosion. It has been noted that synthetic PAO lubricants greatly reduce the frequency of explosions and flash fires.

2.0 Analysis of separator "failures"

2.1 Oil residue inside separator

More than 5 mm of oil in the internal base / bowl of the separator is due to a fault in scavenging.
Determine cause of fault, rectify and re-use separator if not damaged, blocked or aged.

2.2 Saturated separator

Under normal circumstances the wet band, more easily seen on the outer surface of the white filter media than the inner, which is wet with oil being indicated by a golden yellow colour – if not dyed mineral oil is in use – should not extend more than 25 to 50 mm form the separator base.
If the wet band, on examination, extends from the base to the top (flange) or almost to the top then the separator is saturated.
Determine cause of fault, rectify and re-use separator if not damaged, blocked or aged. When starting a compressor with a saturated separator an oil mist will be carried over (can be seen if blown to atmosphere) for a few minutes whilst the separator rids itself of excess oil. During this period the separator differential pressure will lower.
If the differential pressure does not reduce to 0.2 to 0.3 bar within 10 minutes whilst the compressor is on load then the separator should be replaced.

2.3 Discoloured separator – dark amber / brown

Indicates oxidized mineral oil.
Determine compressor / compressor room / ventilation / pollutant fault and rectify, then change oil, oil filter and separator.

2.4 Discoloured separator – grey to black

This indicates dirt retention and / or severe carbonization of oil. Check sealing and integrity of air filter and replace same. Check environmental conditions and rectify where possible. If compressor sounds different to the ear than normal when either n or off load or both then it indicates air-end and / or gear box wear and imminent failure. Compare monitored dB bearing readings to history / maximum allowed. Rectify cause of fault. Do not re-use separator.

2.5 Non-discoloured separator with high differential pressure

Being normal at or beyond compressor manufacturer's recommended change interval; this may be as low as 3000 hours for hot running compressors with small (mineral) oil fill. For cool running compressors or those with a large (mineral) oil fill, this may be 6000 to 8000 hours.
For the many reasons of high differential pressure prior to normal expected life refer to Section 1.0 above. Fine dust particles and extended molecular strings causing blockage do not generally discolour the outer filter media.

2.6 Collapsed separator – no discolouration

Determine cause for high differential pressure which leads to a separator collapsing; compressor mechanical fault – minimum pressure valve or other cause, operational fault – opening or closing too rapidly of discharge air valve. Determine mechanical or operational fault and rectify.

2.7 Collapsed separator – limited discolouration

Determine cause for high differential pressure which leads to a separator collapsing. Possible causes: build up of shellac, dirt or other particles, mixed oils.

2.8 Collapsed separator – grey to black

Determine cause for high differential pressure which leads to a separator collapsing. Possible causes: incorrect oil, sludge formation, dirt, damaged or poor fit of air filter.

2.9 Collapsed separator – black with carbon deposit

Either implosion or explosion; Study soot colour and grain: soot fined grained and grayish indicated an explosion and usually accompanied by mechanical damage to components between and inclusive of the air-end housing and separator tank, soot course grained and blackish indicates a flash fire. Determine cause, repair / overhaul compressor, change separator, air and oil filter and oil.