COMPRESSOR *"HOUSE-WARMING"* PRACTICES

- When the industry commissions a project or its process now, they actually warm up the compressor house and after the commissioning phase, the compressor house warming ceremony over is over and the compressor house heat-up begins leading to accelerated ageing of the compressor and allied equipments within very few years.

- The industry manager erects perfectly the production equipments giving due importance to the on-line and off-line house keeping practices of the production equipments. But when it comes to erection of utility equipments, especially the air compressor finds a place in a remote corner of the premises.

- During the pre commissioning phase of project, the compressor vendor enters and compromises on the compressor location allotted to him, as he could not demand much about his box compressor comfort working requirements!

- Here starts the inefficiency of compressor & auxiliaries in location, orientation, all round space to breathe and vent. Invariably the ref dryer hot side exhausted air will be feeding as air intake to compressor skid area.

- But now the trend is that the industry manager have started consulting with the utility experts or Certified Energy Auditors from the respective utility trades and go in for first hand information only and take the correct step initially during erection, piping & distribution so as to reduce the running losses at compressor house & at the distribution.

- The concerned area utility expert can definitely guide the industry manager at the time of procurement, erection, and in conserving the running cost for the equipment's life period as well.

- **Looking inside the compressor operating system, the Oil is an additive within the system to compress the air coolly and the heat of compression** is taken out by the oil circuit thro the oil heat exchanger from skid top. Visualize in the compressor, the compressed air is very hot at the air end, and the heat is exchanged thro oil and air and expelled thro to top of skid.

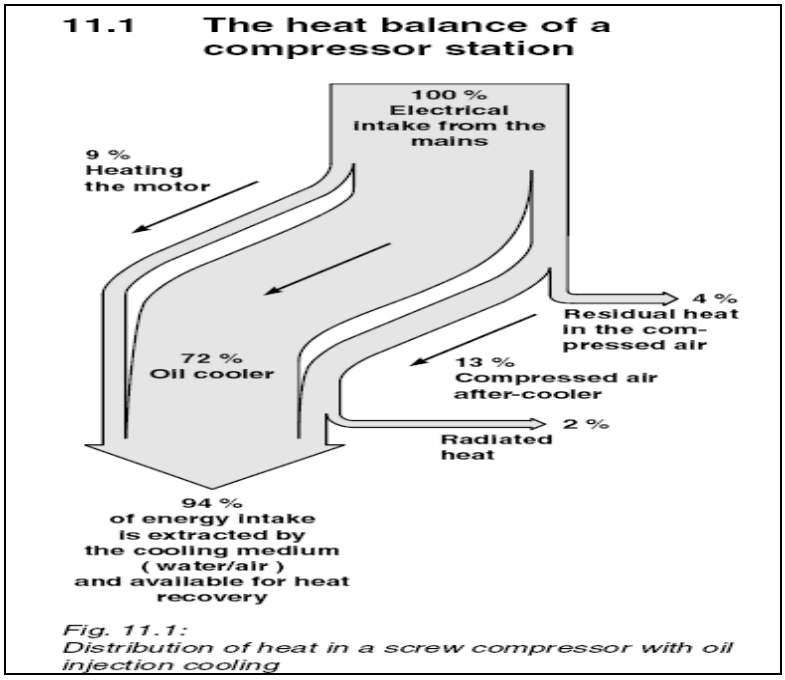
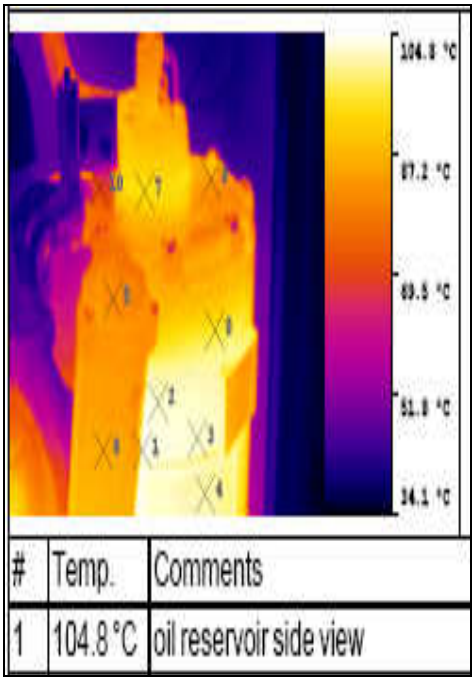


Fig. 11.1: Distribution of heat in a screw compressor with oil injection cooling



- **I image - Kind Courtesy – Heat balance in Compressed Air Compendium by BOGE compressors.**
- **II image -Thermal Image of heated up oil reservoir tank due to poor heat transfer in a field compressor.**

- **Oil injection to compressor element is to act as catalyst to remove the heat of compression of air in discharge**

- Kindly look into the heat balance of an oil injected screw compressor. The heat of compression of air is neutralized by the oil cooler at 72 %. This heat balance will be the focus area for the compressor maintenance man during the condition monitoring of the machine.

- Hence the FAD of the compressor in a compact hood running in an ice cold country very much differs here in hot harsh warm humid conditions in India. Even the local compressor OEM, like their counterparts, are also compacting the hood to save on the volume of compressor skid and pricing. This in turn, makes the consumer to run the compressor with half of the skid doors open during most of the months.

- Compressor is one utility in India, where in International companies are competing with the local utility OEM to supply and serve the industry. But the Indian climate is very much tropicalized and always in a year, we find 2 months cool, 4 months warm and 6 months hotter only now.

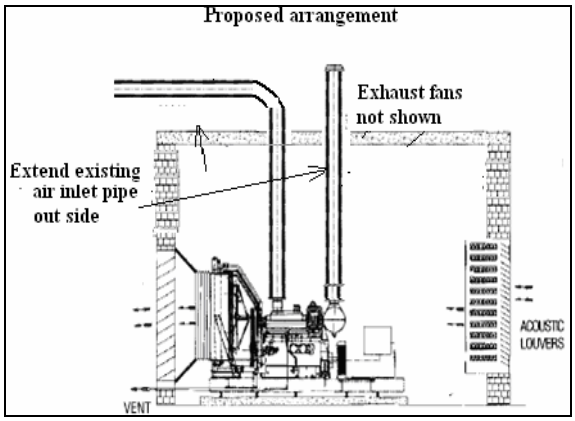
- **As a compressed air consumer what can we do at site during erection of compressor house and during the process running, what retrofitting to do without stopping the compressor utility now?**

- Firstly, to build a separate stand alone compressor house with full openings at all sides up to the lintel level for positive cross ventilation. The bottom of walls can be up to 0.5 meter height to avoid ground dusted air intake to compressor. It must not be attached to any process building inside or outside.

- To avoid the industry product or bye-product like cement powder, textile fluff, foundry dust flying thro air and affecting the compressor, we have to install all- around netlon type or higher micron mesh filter mesh doors on all the four sides. So that the same filter doors can be cleanable daily inside and outside the compressor house.

- After doing the same, the compressor side hood covers can be kept open fully. Or like the compressor house wall filter doors, the compressor hood also can be replaced or retrofitted with the same type netlon mesh doors. But care to take the cleaning to be daily effective inside and outside the skid too.

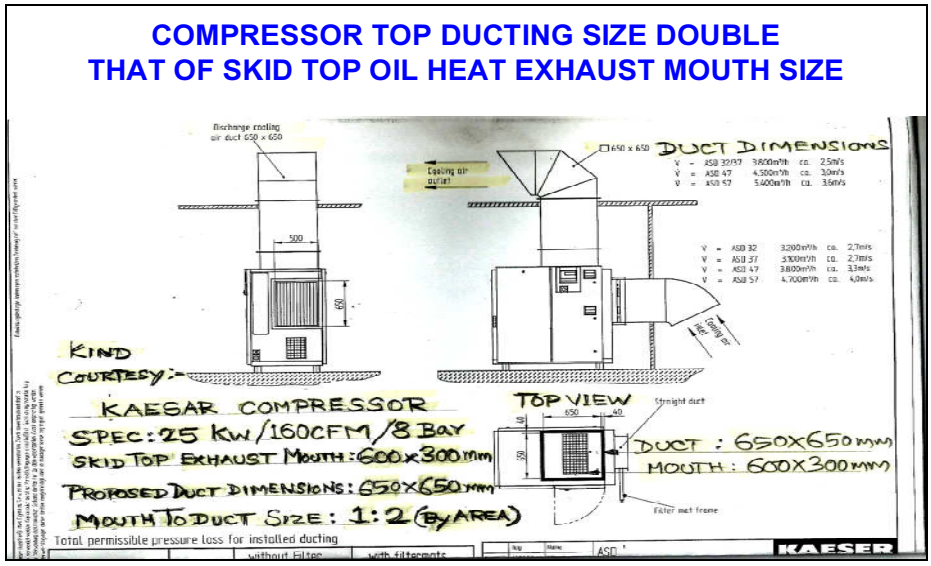
- The compressor house to be fitted with the high volume low static temperature sensing roof vents to function on the compressor house always and equaling the compressor house temperature to that of the ambient temperature outside.

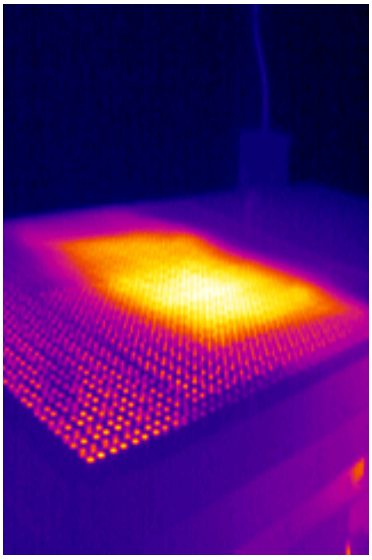


- **I image - Starved and Choked Air intake filter mouth sucks less amount of hot dry air near motor inside hood.**
- **II image – Like top extended air intake on DG skid, same duct extension to top of compressor skid suggested.**
- **III image – V type suction air pre filters on side / this fabricated pre-filter box can be put on skid top - image II**

- The II image is typical of DG genset, extend the air intake piping can be extended to the top of skid and provide Netlon type pre-filter fabricated box cover. The sides of the box and top side can be fitted with slide-in-slide-out (window air conditioner type) filter and the filter pads to be cleaned daily inside and outside.

- The compressor OEM can also give a thought about this feature at the manufacturing facility itself. During the manufacture itself, the compressor running efficiency can be planned to improve at the air intake now. The different types of ducts are tried on compressor oil heat exchanger top.





- **I image – KIND COURTESY -KAESER screw compressor Installation manual mouth to duct ratio 1 : 2 (area)**
  II image – Thermal imaging of oil heat exchanger top view on the skid – Courtesy – R.N.Agencies Field Images.

- Here care should be taken to first expand the duct from the compressor skid top, take short path of duct to get out of building. Here to cut the top mesh on compressor skid top and 100 % more area to expand outside to start with and ducting size expansion depends on the length of duct to outside building. Always plan to short length duct to outside.

- If the heat transfer efficiency of the oil goes down, then automatically the heat is diverted by way of residual heat in the compressed air and the system will go out of balance from generation to usage point.

- So it is high time, he industry has to switch over to synthetic lubricant to achieve the host of benefits. The intangible benefits are more in this specialty lubricant app apart from energy saving aspects; pls keep aside the high costs!!

- **<u>All the above three images are not expand-ducted out and hence cause poor heat transfer efficiency of oil exchanger. Please do not be economical in ducting size while expelling the heat out of building.</u>**

- The refrigeration dryer is like the window air conditioner only, since it conditions the compressed air. Can we run a window air conditioner by locating in the center of the compressor house in 24 x 7 hour mode! So it is sensible to duct out condenser heat away from the top like the flume chute or thro a side duct to the wall to outside the building.

- Here again the differential temperature from the dryer outlet to be less by a minimum of 5 to 10*C compared to dryer inlet and as well must be less than the ambient temperature. Here addition of a post air heat exchanger cum cooler will reduce the burden of dryer and air is first cooled mildly up to wet bulb ambient temp and then cooled by refrigeration means of drying.

Ambient temperature t_A [°C]	25	30	35	40	43
Factor t	1,00	0,92	0,85	0,79	0,75

Op. pressure p [bar_{op}]	2	3	4	5	6	7	8	9	10	11	12	14	16
Factor f	0,62	0,72	0,81	0,89	0,94	1	1,04	1,06	1,09	1,1	1,12	1,15	1,17

A BOGE refrigeration compressed air dryer, model D8, has a through-flow rate R of 45 m³/h. It is operated at an average ambient temperature of t_A = 40° C and an operating pressure of p = 10 bar_{op}.

R = 45 m³/h
p = 10 bar_{op} ⇒ f = 1,09
t_A = 40° C ⇒ t = 0,79

R_{Ad} = Adjusted through-flow rate [m³/h]
R = Through-flow rate [m³/h]
f = Conversion factor for p = 10 bar_{op}
t = Conversion factor for t_A = 40° C

With changed operating conditions the dryer has through-flow rate of 38,75 m³/h.

$R_{Ad} = R \times f \times t$
$R_{Ad} = 45\ m^3/h \times 1,09 \times 0,79$
$R_{Ad} = 38,75\ m^3/h$

- **Kind Courtesy –Ref dryer De-rating in Compressed Air Compendium by BOGE compressors.**

- When the industry manager buys a compressor & dryer as a system, he buys a matched CFM set as compressor FAD 100 cfm and the dryer 100 cfm rated. Given the temperature band of dryer operation, the dryer de-rates by 25 % from 25*C to 43*C raise in air inlet temp. So the pressure drop increases more than 1 Kgsc or so across the de-rated dryer. **So we have to procure 50% minimum more CFM capacity of the dryer to that of compressor CFM.**

- One more reason for this higher air inlet to dryer is that is the orientation of dryer skid with respect to the compressor skid. The heat exhausted by the refrigeration of dryer is directed towards the compressor air intake suction side of compressor skid.

- Thereby short circuiting the hot exhaust air of say 100 cfm air at 45*C is brought down by the ref dryer. That amount of heat expelled by the dryer comes back to suction of compressor as air intake at 45 *C when the ambient is around 32 *C and here we lose 3% energy loss in the compressed air generation due to wrong orientation of compr. & dryer.

- The temperature difference between air intake and the compressor discharge point / air receiver temperature to be less than 5 *C. This is again sensed by a differential thermostat and the alarm set differential shows that the heat of compression in the air is not removed by the oil circulation.

- The healthy indicators for a compressor house is that the pressure drop from the compressor skid to air receiver / main air header pressure out of compressor house must be very much less than 0.3 Kgsc or less. Here differential pressure indicator along with audio visual alarm with remote indication can be retrofitted in the compressor house. When alarm comes ON, this shows compressor house is not healthy.

- The temperature difference between the compressor air intake at skid temperature and the outside the compressor house ambient temperature to be zero. Here too, we can retrofit a RTD based digital alarm based differential sensing indicator for the in & out, to give alarm on house warming temperature.

- Now we understand that this compressor house warm –ups in the industry are silently going un-noticed and the sustained efficiency of the compressed air utility is gradually getting lost starting from the compressor house. If the industry revisits to the compressor house improvements, in the aspects house temperature gradient in & out of the compressor skid & the house, then the industry is assured of energy savings based on the above health recovery.

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