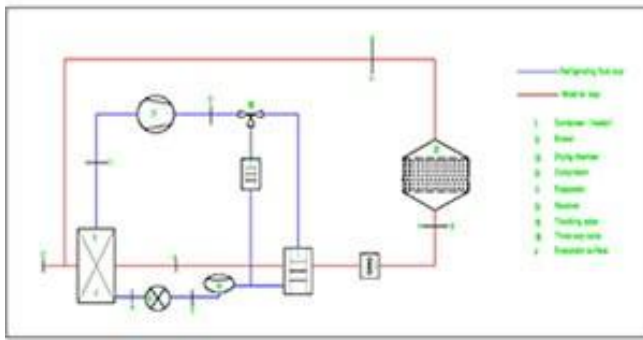

Single Stage Vapor Compression Heat Pump Dryers Design Example

A modern alternative for substantial energy recovery with suitable drying rates is the heat pump drying technology operating with full re-circulation of the exhaust air. The main features of the heat pump dryer are the ability to fully recycle exhaust air by using a closed loop design, condensation of water vapor in the air and energy transfer for boiling the refrigerant inside the evaporator, with subsequent release of this energy to the air inlet during condensation of refrigerant inside the condenser.

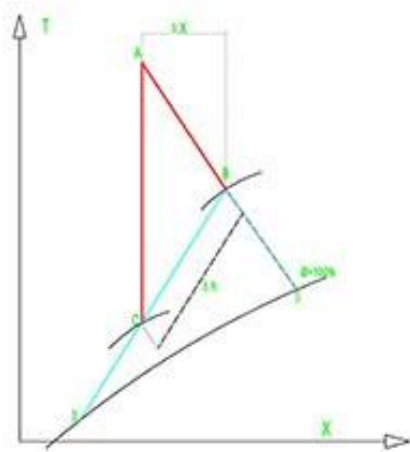
Heat Pump Drying of Onion Flakes Design Example

[From: heat pump dryers -theory,design and industrial applications]



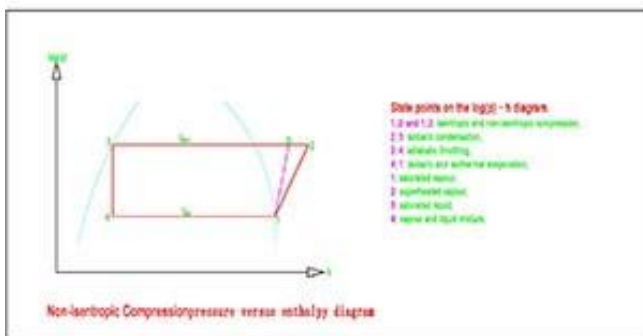
A pilot heat pump fluidized bed dryer working with R22 refrigerant used to dry $5 \times 5 \times 8$ mm onion flakes with a water removal rate of 30 kg/h. The drying chamber inlet air temperature and relative humidity are 40°C and 20%, respectively, and the outlet air relative humidity is 70%. The evaporating temperature is 7.78°C ; the condensing temperature is 45°C ; And the isentropic and volumetric efficiencies are 0.6 and 0.7, respectively. Saturated vapor is compressed and saturated liquid is throttled adiabatically. Consider that drying is adiabatic and at atmospheric pressure and calculate the compressor shaft work and volumetric flow rate, evaporating and condensing capacities, COP, SMER and the total energy paid.

1. The air state points for the heat pump drying cycle in the Mollier diagram



| Point | A | B | C | D |
|------------------------------|-------|-------|--------|-------|
| Temperature, °C | 40 | 26.1 | 13.68 | 7.78 |
| Relative humidity | 20% | 70% | 94.30% | 100% |
| Absolute humidity g/Kg | 9.20 | 14.8 | 9.20 | 6.56 |
| Enthalpy KJ/Kg | 63.86 | 63.86 | 36.96 | 24.30 |
| Dew point Temperature, °C | 12.78 | - | - | - |

2. R22 State points on the log(p)-h diagram



| Point | 1 | 2 _i | 2 | 3 | 4 |
|--------------------------|--------|----------------|---------|---------|--------|
| Temperature, °C | 7.78 | 61.28 | 79.76 | 45 | 7.78 |
| Absolute Pressure KPa | 636.02 | 1728.43 | 1728.43 | 1728.43 | 636.02 |

| | | | | | |
|---------------------------------------|--------|--------|--------|--------|--------|
| Enthalpy KJ/Kg | 408.17 | 432.95 | 449.47 | 256.46 | 256.46 |
| Entropy KJ/Kg.K | 1.74 | 1.74 | 1.79 | 1.19 | - |
| Specific volume m ³ /Kg | 0.0371 | - | - | - | - |

3. Heat pump system

| | | | |
|-----|---------------------------------------|------------------------------------|------------------------|
| 3.1 | Evaporating capacity | $Q_{ev} = W / \Delta X * \Delta h$ | 39.97 Kw |
| 3.2 | R22 mass rate | $Mr = Q_{ev} / (h_1 - h_4)$ | 0.2635 Kg/s |
| 3.3 | Compressor shaft power | $W_0 = m_r * (h_2 - h_1)$ | 10.88 Kw |
| 3.4 | Volumetric flow rate of compressor | $V_i = 3600 * m_r * v_1 / \eta$ | 50.28m ³ /h |
| 3.5 | Condensing capacity | $m_r * (h_2 - h_3)$ | 50.85 Kw |
| 3.6 | COP | Q_{ev} / W_0 | 3.664 |
| 3.7 | SMER | W / W_0 | 2.750 Kg/Kwh |
| 3.8 | E_{use} | 1/COP | 27.3% |

Ref to: [Heat Pump Dryer Machine for Food and Vegetables](#)

Back to: [Hot Air Dryer](#)

Product link : <https://www.french-fries-machine.com/product/single-stage-vapor-compression>