Where is vacuum used?

Freeze drying is a sublimation process where the solvent, usually water, is directly vaporised from its solid phase. Water sublimation takes place at a pressure lower than 6.1 mbar, the saturation vapour pressure of ice at 0°C. However, most freeze drying applications are carried out at pressure of 0.05 to 1 mbar depending of the product to be dried.

Freeze drying avoids chemical, physical and enzymatic changes associated with other forms of drying and is the optimum process of selection for unstable, heat liable products, like pharmaceutical or blood plasma derivatives. The end product is highly porous mass having the same size and shape as the originally frozen material.
Typical freeze drying system

A freeze dryer consists of a vacuum chamber accommodating refrigerated and heated shelves connected to a refrigerated condenser piped to a vacuum pumping system. Sublimed water is pumped by the refrigerated condensers at ~70°C.

The vacuum pumping system need to meet the following major requirements:
- Ensure pump down of chamber and condenser to ~ 0.05 mbar in less than 30 minutes
- Ensure fast pump down below 1 mbar
- Ensure final vacuum of 0.01 mbar or lower in the chamber
- Ensure reliability, as loss of vacuum during sublimation process can damage the product or the entire batch
- Provide clean vacuum, especially for pharmaceutical injectable
- Avoid cross contamination between cycles
- Monitor vacuum level to ensure repeatable process performance

**Solutions**

### Dry Pumping systems - Recommended technology

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<th>Recommended Models</th>
<th>iXL dry pumps</th>
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<td>iXL dry pumps</td>
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<td>GXS750, GXS750/2600, GXS750/4200</td>
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</table>

**Benefit:** Dry pump systems substantially reduce the maintenance and operating costs
- A large tolerance to water vapour and solvents traces that may be added to increase solubility
- Clean residual vacuum
- Elimination of oil back streaming which is a source of contamination in the pharmaceutical injectable solution
- No cross contamination due to cleanable internal swept volume

### Oil sealed pumping systems - Conventional technology

<table>
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<tr>
<th>Conventional Models</th>
<th>EH Mechanical booster pumps</th>
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<td>EH4200</td>
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</tbody>
</table>

**Benefit:** Generally, oil sealed pumps have higher operating and maintenance costs. However two stage oil sealed rotary vane pumps have been the conventional technology before the introduction of dry pumping.
- High ultimate vacuum for optimum final drying
- High reliability
- Proven technology in freeze drying processes

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Edwards’ Benefits

GXS dry screw pumps

The GXS range featuring intelligent on-board control has been developed using new variable pitch tapered screw technology for exceptional performance and reliability. Available in pumping speed from 160 m³h⁻¹ to 750 m³h⁻¹ and when combined with GMB vacuum boosters, speeds of up to 3,450 m³h⁻¹ can be achieved.

- **Highly reliable**
  Ability to handle harsh processes

- **Low maintenance cost**
  No unplanned down-time

- **Increased productivity**
  Longer intervals between services

- **Safe operation, consistent output**
  Automated control of your process

- **No loss of expensive products**
  Reliable

- **Increased Productivity**
  Longer interval between services

iXL dry pumps

iXL is the most compact and low energy dry pump option. It is available as the iXL120N stand-alone unit delivering pumping speed of 110 m³h⁻¹, or as the iXL1000N combination, which includes an inverter-driven booster delivering 930 m³/h⁻¹ peak pumping speed. Equipped with Intelligent on-board controller, delivers the same benefits of GXS to freeze drying process. In addition:

- **Perfect integration in pilot freeze dryers**
  Smaller foot print than similar pumping speed

- **Comfortable workplace**
  Extremely quiet running
**EH Mechanical booster pumps**

Edwards EH mechanical booster pumps represent the industry standard for mechanical booster pumps, available in displacement 310 to 4985 m³h⁻¹. EH range features the unique hydrokinetic drive with a fluid coupling that physically regulates transmission of power by limiting torque from motor to rotors.

**Increased productivity**
- Faster pump down time

**Peace of mind**
- Industry proven with large install base

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**E2M two stage oil sealed rotary vane pumps**

Edwards EM two stage oil sealed rotary vane pumps represent the industry standard for two stage oil sealed rotary vane pumps, available in displacement 42 to 350 m³h⁻¹. E2M range features high ultimate vacuum than comparable technology, no loss of expensive products, and reliable performance.

**Process performance**
- High ultimate vacuum than comparable technology

**No loss of expensive products**
- Reliable

**Peace of mind**
- Industry proven with large install base

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