Step 1: Establish the Component Masses Based on Dry Solid Conservation

In any drying process, the total mass of any stream is composed of the bone-dry solid substrate (m_s) and the associated moisture mass (m_W). The moisture percentages provided are on a **wet basis** (y), meaning they are calculated relative to the total mass of that specific stream.

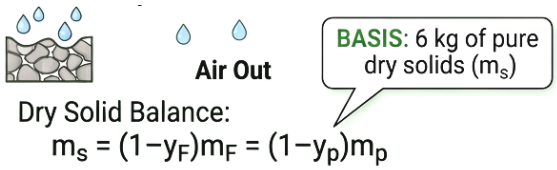
- **Wet Feed Moisture (y_F):** 18% water ⇒ Dry solid content is 100% - 18% = 82% (0.82).
- **Dried Product Moisture (y_P):** 2.5% water ⇒ Dry solid content is 100% - 2.5% = 97.5% (0.975).

The problem dictates that we must evaluate the process per 6 kg of pure dry solids:

$$m_S = 6kg$$

Step 2: Determine Total Feed Mass (m_F) and Total Product Mass (m_P)

Since dry solids do not evaporate, the absolute mass of solids entering in the feed must equal the absolute mass of solids leaving in the product. We use this identity to find the overall stream weights.



For the entering wet feed:

$$m_S = (1 - y_F)m_F$$

$$6\,kg = (1 - 0.18)m_F$$

$$m_F = 7.3171\,kg\ of\ total\ wet\ feed$$

For the exiting dried product:

$$m_S = (1 - y_P)m_P$$

$$6\,kg = (1 - 0.025)m_P$$

$$m_P = 6.1538\,kg\ of\ total\ dried\ product$$

Step 3: Calculate the Mass of Moisture Removed (Δm_W)

The mass of moisture removed by the dryer is simply the difference between the total mass entering the system and the total mass exiting the system:

$$\Delta m_W = m_F - m_P = 7.3171\,kg - 6.1538\,kg$$

$$\Delta m_W = 1.1633\,kg$$

1.1633 kg of moisture is removed per 6 kg of dry solids.

In chemical, agricultural, and manufacturing processes, raw materials constantly change density, volume, and total mass as they are treated. Tracking total wet weights often leads to design errors. Smart engineers always isolate and base their calculations around the **unchanging carrier metric** (bone-dry solids in dryers, dry air mass flow in HVAC units).

Knowing that exactly 1.1633 kg of water is liberated for every 6 kg of processed solids allows an engineer to size the heating elements. Because evaporating water requires overcoming the latent heat of vaporization (2257 kJ/kg under standard conditions), calculating the precise mass of water removed tells you exactly how many kilowatts of thermal energy must be continuously injected into the drying chamber to keep production moving.