Material balance calculations for jams and marmalade preparations

<u>Difference between jams and marmalades</u>

Contains whole fruit or fruit pieces: **<u>JAMS</u>**

Contains fruit pulps: **<u>MARMALADES</u>**

No fruit piece, made from juice, clear appearance; **<u>JELLY</u>**

Jam

- Contains **fruit pieces** (whole or pieces).
- Fruit is heated with sugar, acid and water to activate the pectin (gelling agent) in the fruit.
- If the fruit do not contain enough pectin and acid, then pectin and acid (such as citric acid) are added.
- Whole berries (such as sour cherries) are most frequently used without crushing.
- Larger fruits such as apricots, peaches and quinces are used after cutting into small pieces.

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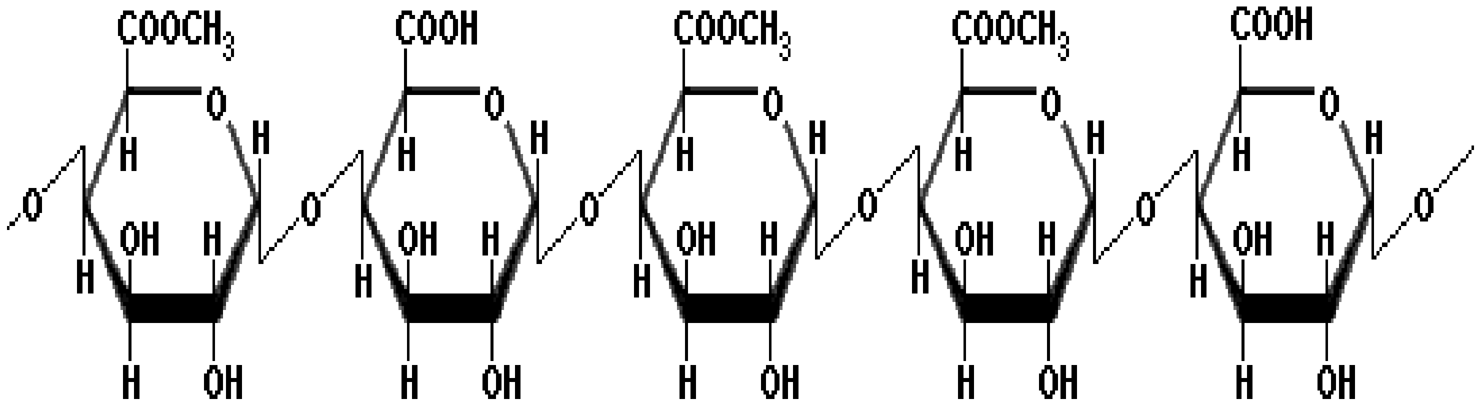


- **Good jam** has a soft even consistency, a bright color, a good fruit flavor and a semi-jellied texture that is **easy to spread** but has no free liquid.

Marmalade

- In Europe, marmalade impies by heating **citrus fruit rind** (most popularly oranges), with **pectin**.

- In Turkey, marmalade implies by heating **fruit pulps** with **pectin**.

Fruit spread

- Refers to a jam or preserve with **no added sugar**.

Jelly

- Obtained by heating the **fruit juice** with **pectin**.

- After initial heating, fruit pulp is filtered out.

- Good jelly is **clear** and is tender (not hard), enough to vibrate when moved.

Other than these produts;

In the United States and European countries, the following two products are also produced.

- **Preserve:** Obtained from whole fruit and contains significant amount of fruit. (extra geleneksel reçel)

- **Fruit spread:** Preserve not containing sugar.

- **Example 3.21**: The standard identity for jams and preserves specifies that the ratio of fruit to added sugar in the formulation is 45 parts fruit to 55 parts sugar. A jam must have a soluble solid content of at least 65% to produce a satisfactory gel. The standard identity requires soluble solids of at least 65% for fruit preserves from apricot, peach, pear, nectarine, plum, figs, and quince.

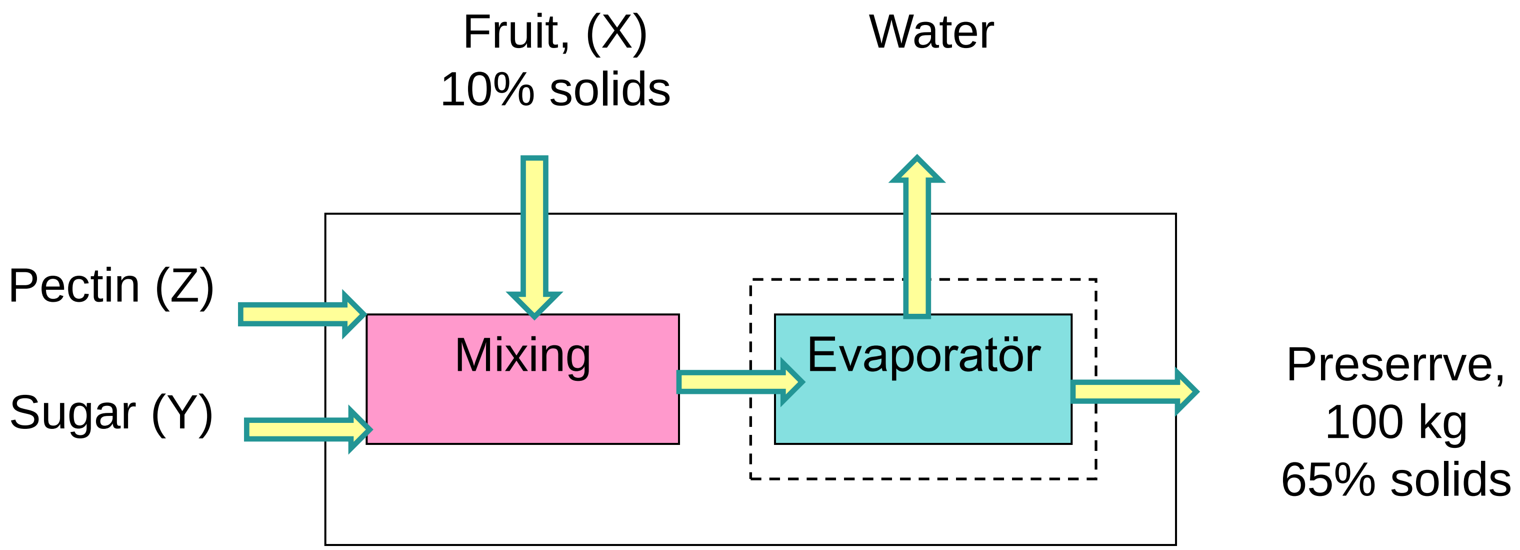
- If the fruit contains 10% soluble solids and 100 grade pectin is used, calculate the weight of the fruit, sugar, pectin and the amount of water evaporated to produce 100 kg of fruit preserve.

The process of making fruit preserves involves mixing the fruit and sugar in the required ratio, adding pectin and acid, and the concentrating the mixture by boiling in a vacuum and atmospheric pressure in a steam jacketed kettle until the soluble solid content is at least 65%.

In soluble solid mass balance, the soluble solids, acid content and sugar are considered soluble solids; pectin excluded.

- ***Pectin grade*:** A 100 grade pectin is one that will form a satisfactory gel at a ratio of 1 kg pectin to 100 kg sugar. A 150 grade pectin is one that will form a satisfactory gel at a ratio of 1 kg pectin to 150 kg sugar.

Flow diagram for marmalade production



Answers

X = **49 kg fruit**

Y = **60 kg sugar**

Z = **0.6 kg pectin**

- **Example 3.22**: The Turkish standard identity for apricot marmalade specifies that the final product should contain 40% apricot pulp (in essence "pure fruit"). The marmalade of 150 kg with 68% soluble solids will be produced from the fruit at 14% soluble solids. To produce 150 kg of apricot marmalade, calculate:

a) the weight of the apricot pulp, sugar, acid and pectin,

b) the weight of the sugar and water to prepare pectin solution (3%),

c) the amount of water to be evaporated in this process.

Data

- For the production of 150 kg marmalade, 600 g of citric acid will be used, in addition to the acid naturally present in the fruit. Citric acid will be added at 50% aqueous solution.
- Pectin of 150 grade will be used. The pectin used in this process will be mixed with 5 times its weight of sugar. The pectin will be added as 3% solution.
- The glucose syrup will be added at a concentration that the final product will contain glucose syrup at 5% of its weight. The soluble solid content of glucose syrup will be 80%.

Flow diagram for marmalade production

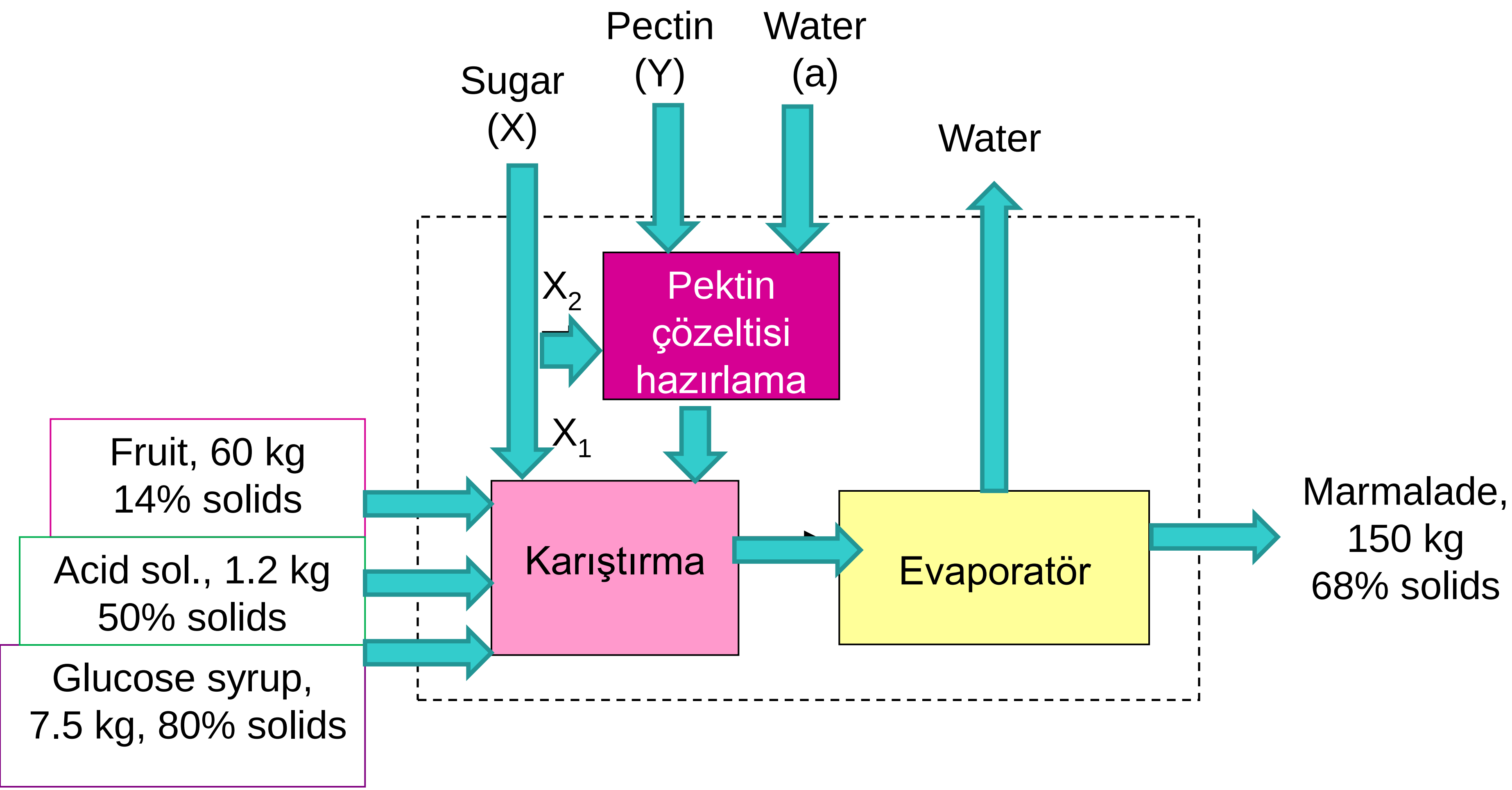


Table 1 The recipe used for the production of 150 kg of apricot marmalade

Ingredients	**Weight (kg)**
Apricot pulp	60
Citric acid solution (50%)	1.2
Glucose syrup (80%)	7.5
Sugar	87
Pectin	0.58
Water	15.85
Total	172.13

Result

- The content of recipe should be cooked up until **<u>22.13 kg water is evaporated</u>**. After evaporating 22.13 kg water, the marmalade (150 kg) will contain 68% soluble solids.

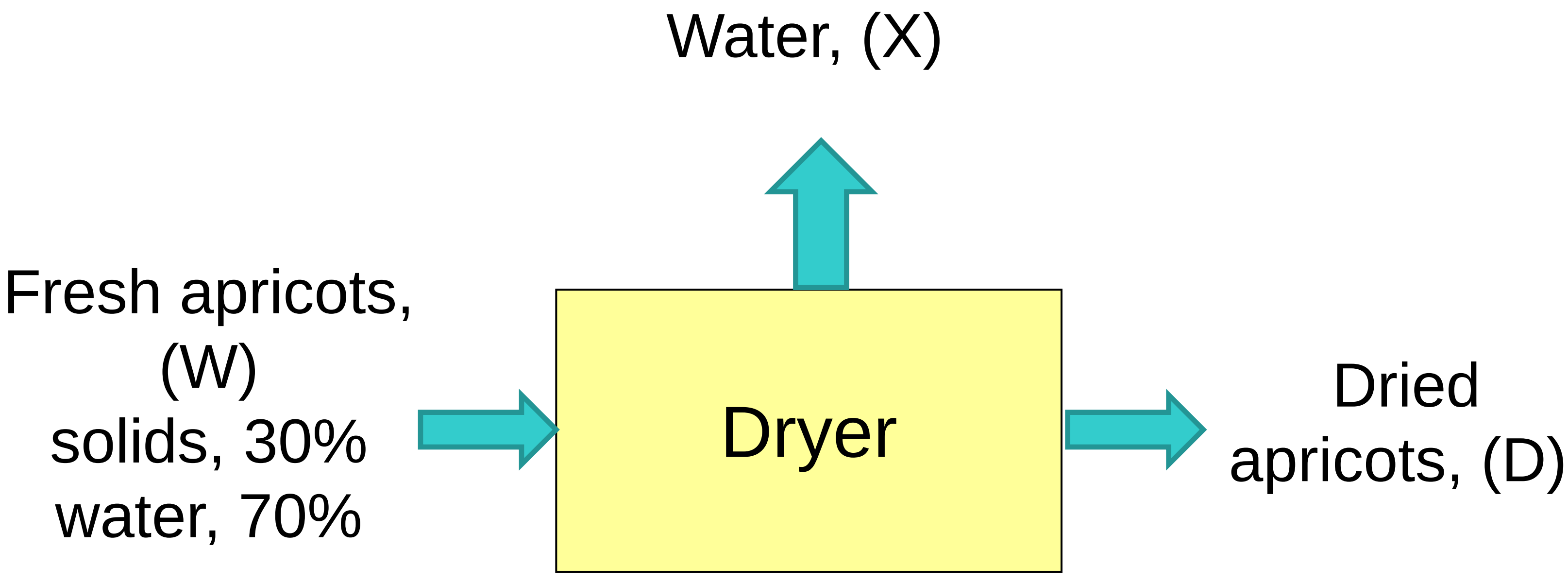
Material balance calculations for drying of foods

Example 3.23

After drying of food initially containing 70% moisture, 80% of its moisture content was removed. Find out:

a) the moisture removed on the basis of 1 kg of wet material.
b) The composition of dried food.

<u>Flow diagram for dehydration of apricots</u>



Answers

a) 0.56 kg moisture/1 kg wet material
b) 68.18% dried matter
   31.82% moisture

Example 3.24

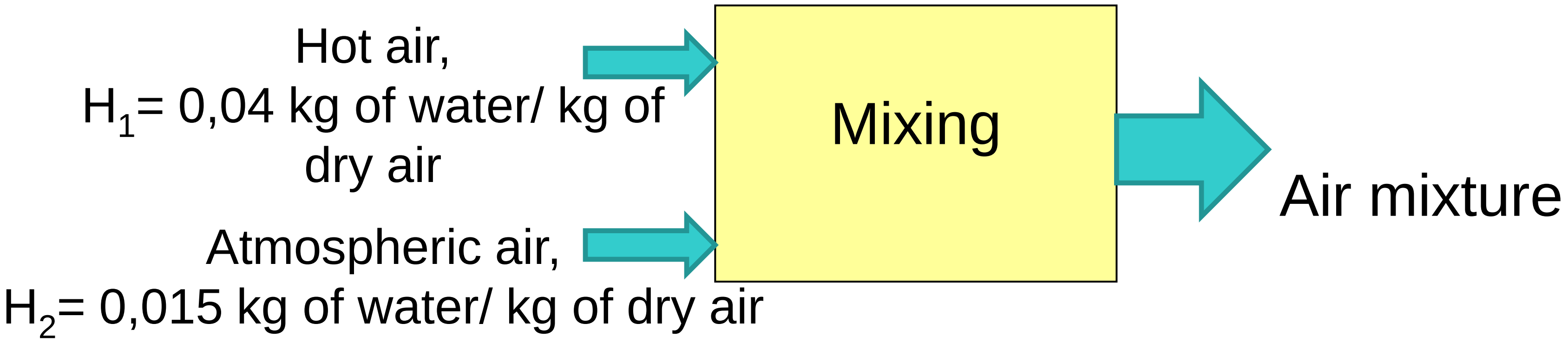
How much weight reduction would result when apricots are dried from 80% moisture to 18% moisture?

- **Example 3.25**: 2080 kg/min of the hot air left from a dryer with the absolute humidity (mutlak nem) of $H_1 = 0.04$ is mixed with 9135 kg/min of the air taken form atmosphere with the absolute humidity of $H_2 = 0.015$. By this process, after heating this mixture, the relatively hot and dry air is sent back to the dryer. Find out the absolute humidity of air mixture (H_3).

- Absolute moisture is expressed as “kg of water vapor/kg of dry air.” For example, if the abolute moisture of air is 0.04, then this air contains 0.04 kg of water vapor per kg of dry air.

- When the mass of wet air is given, this air is composed of dry air and water vapor carried by dry air. For example, if the absolute moisture content of air is 0.04, then the mass of this air mixture is 1.04 kg of dry air + water (1 kg of dry air and 0.04 kg of water vapor).

Mixing of two air mixture with different moisture content



- **Example 3.26**: 2000 kg of fresh carrots with 88% moisture are dried to the moisture content of 4%. Hot air enters the dryer with the absolute humidity of “0.01 kg water/kg dry air,” and then leaves the dryer with the absolute humidity of “0.0225 kg water/kg dry air.” Find out the masses of dried carrots leaving the dryer, and the hot air entering the dryer as dry and wet air.

Dring of carrots in dehydrator