Luxembourg esero EUROPEAN SPACE EDUCATION RESOURCE OFFICE
A collaboration between ESA & national partners

EXPERIMENTAL SHEET : MANUFACTURE OF A PROPELLANT

1) What is a propellant?

- A propellant is a propulsion product, consisting of a mixture of oxidant and fuel, the propellants. The chemical reaction between this oxidant and this reductant provides the energy for the rocket engine.
- Our rocket fuel, called 'rocket candy', is a composite solid rocket fuel because the oxidising compound is dispersed as very fine crystals in the mass of a binder (the fuel). It is only used in amateur rocket construction.

2) Ingredients

Our propellant consists of :

- potassium nitrate KNO_3 , used as an oxidizer ;
- sucrose (sugar), used as fuel ;
- To improve the fuel's capacity, a catalyst (such as iron(III) oxide (Fe_2O_3)) can be added in small proportions (1g);

3) Security aspect

- Wear suitable clothing and protective glasses and gloves.
- Composite propellants are very stable, they do not tend to explode spontaneously, and are therefore relatively safe, however rocket candy is extremely flammable. Prepare only small quantities.
- Also beware of the risk of burning during filling.

4) Procedure and proportions

- Its production requires 65 grams of KNO_3 , 35 grams of sugar and 1 g of iron III oxide.
- Stir the mixture in a pan with 20 mL of water so that the compounds are completely dissolved.
- Using an electric griddle (no flame), heat the pan over a low heat to evaporate the water, stirring constantly, until a dough of the consistency of bread dough is obtained.
- Insert the paste into the rocket motor while it is still hot and insert a pencil to create a nozzle.
- For lighting, 10 cm of wick can be used.

5) The chemical reaction

- The reaction scheme is as follows:

$$48\ KNO_3 + 5\ C_{12}H_{22}O_{11} \rightarrow 55\ H_2O + 36\ CO_2 + 24\ K_2CO_3 + 24\ N_2.$$

- Since composite mixtures burn relatively slowly (at most a few centimetres per second), a large enough combustion surface is required to provide sufficient thrust to get the rocket off the ground.
- The solution chosen by many amateurs is to make a block of propellant that burns through the centre (thanks to a cylindrical chimney).