CHAPTER 8

THE MAIN CHARACTERISTICS OF THE PROPELLANT

Composition:	60% KNO_3 – 40 % sugar
Reaction temperature:	1560°K
Heat of reaction:	46,6 kcal/100 g
Specific heat ratio:	1,2447
Molecular weight:	30,464
Characteristic velocity:	991 m/s
Summerfield criterion:	Pe/Pa ≥ 0,45
Specific impulse:	90 – 140 s
Propellant density:	1,65 – 1,80 g/cm^3
Melting point:	177°C
Ignition temperature:	315°C
Correction coefficient for the characteristic velocity:	0,988
Correction coefficient for the thrustcoefficient:	0,883
Overall correction coefficient for the thrust (θ = 15°):	0,857
Burning rate coefficient:	0,200 – 0,220 cm/s (centrifugated)
	0,110 – 0,330 cm/s (casted)
Burning rate exponent:	0,40 – 0,42 (centrifugated)
	0,60 – 0,70 (casted)

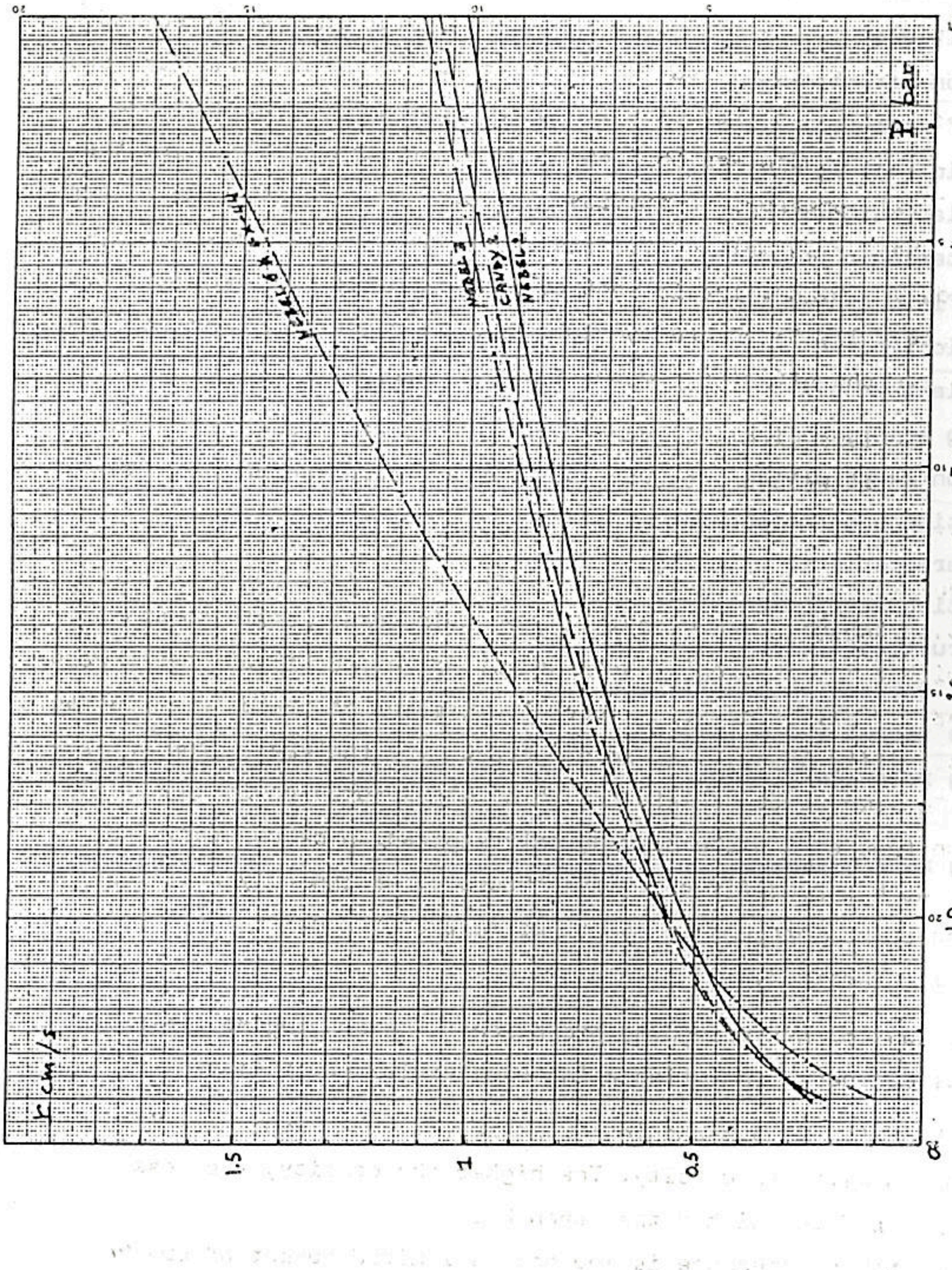

Fig.8.1. The burning rate for both centrifugated and casted propellants

CONCLUSION

From the comparison between testmeasurements and thermodynamical calculations, we were able to correlate the most important thermodynamical properties of the propellant and to find the efficiencies at which the gases are transformed into kinetic energy. It showed that the theoretical calculations are correct and that the flow over the rocketnozzle occured with too high losses. This ofcourse was due to the bad shape and the rough surface of the nozzle. Also the ratio of exit pressure to outside pressure when the gases no longer contact the nozzle wall - i.e. the Summerfield criterion - was determined. Its high value is another indication of the roughness of the nozzle wall. So we are convinced that the use of better nozzles can improve the efficiency with some percentages.

Storage problems with this very high hygroscopic propellant were solved, and it will not prevent any larger scale use of this propellant.

The biggest problems come from the mechanical strenght of the propellant. Although we knew from the beginning that something was wrong with the mechanical behaviour, it was not until all tests were finished and all information resembled,that a lot could be explained. The possibility that the grain can break, was the key to the explanation. For two NEBEL rockets the thrust-time curve could completely be reconstructed and the burning rate expression calculated. For rockets with a crucifix core, the thrust curve can only partly be explained. What happens in the first part of the diagram is still not well understood.

For the case of centrifugated propellants the burning rate expression was derived, indicating a low sensitivity for pressure.

It is shown that the mechanical behaviour of the propellant is in relation with its density. The higher the density, the less airbubbles and the higher the strenght.
When the chamber pressure is low only a limited number of cracks were found. Higher pressure increases the number of cracks, and makes the thrust-time diagram degressive.

Further research on potassiumnitrate and sugar has in the first place to deal with grain design. What shape is less or almost not succeptable to cracks and is still more or less a neutral burner? If we could use such a grain, the thrust curve would be almost ideal. Secondly a good solution has to be found for the propellant grain to stick better to the motor case. Indeed we are convinced that in some cases,i.e. by cracks in the grain and consequently in the inhibitor,parts of the propellant may by vibration separete from the wall. This may cause pressure increase and even explosion. In the third place the specific impulse can be increased by the use of alumina. Even the use of small amounts will cause significant improvement.