APPLIED SCIENTIFIC RESEARCH CORPORATION OF THAILAND

MISCELLANEOUS INVESTIGATION NO. 49
STEEL AND MANUFACTURING PROCEDURE FOR TAPIOCA
PELLETIZING MACHINE COMPONENTS

REPORT NO. 1
DIE AND ROLLER STEELS FOR PELLETIZING TAPIOCA

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By L.S. Knudsen* and Suwat Riebroicharoen+

SUMMARY

By examination of original imported spare parts for pelletizing machines, the types of steel used and the heat treatment applied in the manufacture of the die and roller have been determined. Based on the findings appropriate recommendations on the manufacture have been given.

INTRODUCTION

There are in Thailand eight factories which produce animal feed pellets from tapioca. The pellets are produced in special machines, which in principle consists of a revolving honeycombed die and a set of six rollers. In Figure 1 a worn out die with one roller in working position, are shown.

Both the die and the rollers are subject to heavy wear not only from the tapioca itself, but also mostly from sand and other impurities which are present at about 3-5%. The die and the rollers are worn out after approximately 700 hours of service, at a production rate of 3 tonnes/hour. Figure 2 shows a comparison between a worn roller and a new roller.

The price of an imported die is about 8,000 baht and of a set of 6 rollers about 8,500 baht. The estimated cost of the import of these parts for all eight factories is nearly 10 million baht per year.

A prospective local manufacturer of the parts has tried to make them locally with ordinary mild steel at about half the cost of the imported parts, but due to the lower wear resistance of mild steel the service life was claimed to be halved. However, because of the low efficiency of operation, TRI was asked to advise on an appropriate choice of material and heat treatment to achieve better performance.

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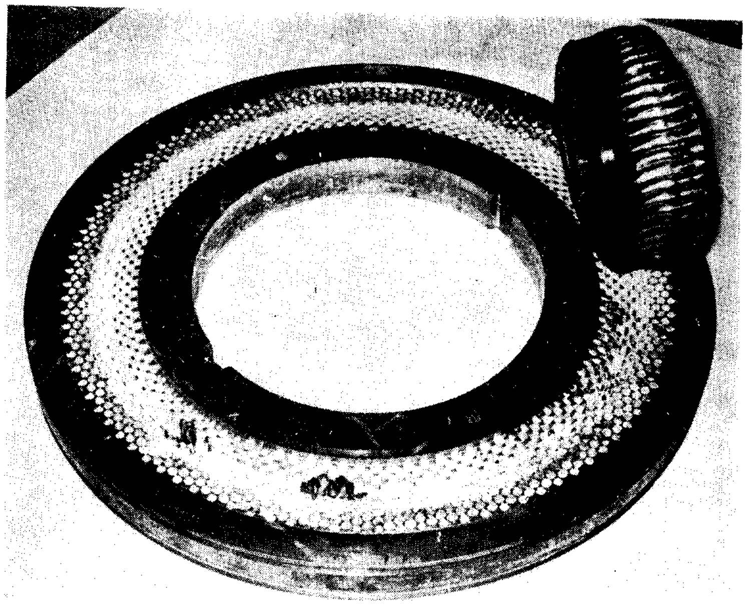

Figure 1. Die and one roller in working position.

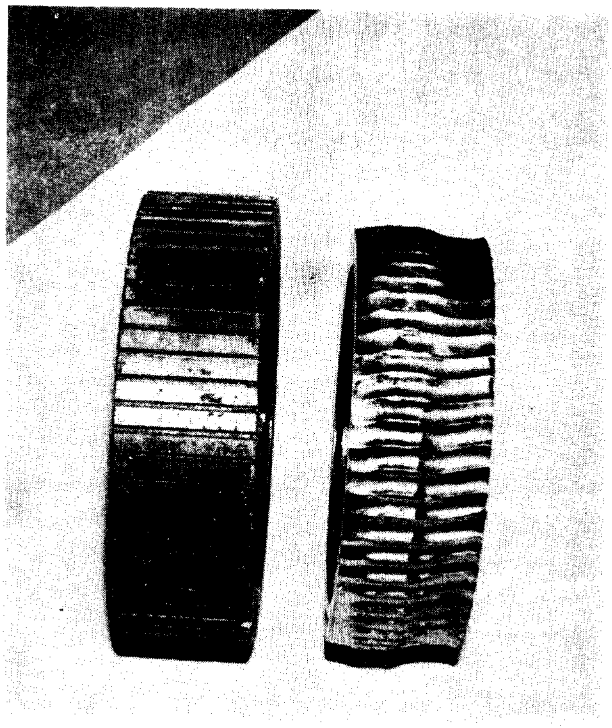

Figure 2. New and worn roller. Note the appearance of the worn roller, which indicates a surface hardening.

MATERIALS AND METHODS

It was considered that an examination of the original imported parts would give a good background for recommending type of steel and manufacturing procedure. A worn out die and roller and a new roller were therefore obtained from one of the factories. The steels were analysed and a microscopic examination as well as hardness tests were carried out.

RESULTS AND DISCUSSION

The results from the analysis are shown in Table 1.

TABLE 1
COMPOSITION OF STEEL USED FOR DIE AND ROLLER

	% C	% Si	% Mn	% Cr	% Ni	% Mo
Roller	0.22	0.31	1.16	0.84	0.10	0.04
Die	0.63	0.38	0.91	0.99	0.23	0.06

The microstructure of specimens taken from the roller (Figure 3) shows that the roller is case hardened either by pack-carburizing or by liquid carburizing. The results of the hardness tests of the roller are shown in Figure 4, where the hardness is plotted in relation to the depth, indicating a case depth of about 2 mm.

The fine grained material together with the design of the roller indicates that the roller is initially a forging.

The composition of the die shows that it is a high carbon (about 0.6%) 1% manganese and 1% chromium steel. The microstructure of the steel from the die (Figure 5) shows a very fine grained material. The form and distribution of inclusions indicates that the die is initially a casting. To give the die a reasonable wear resistance combined with the necessary toughness of the thin walled honeycombed section, it must have been hardened and tempered at a relatively high temperature. The hardness of about 235 HV confirms this view. Decarburization must be prevented during the high temperative treatment, either by the use of salt bath or by the usual packing practice. The design of the die

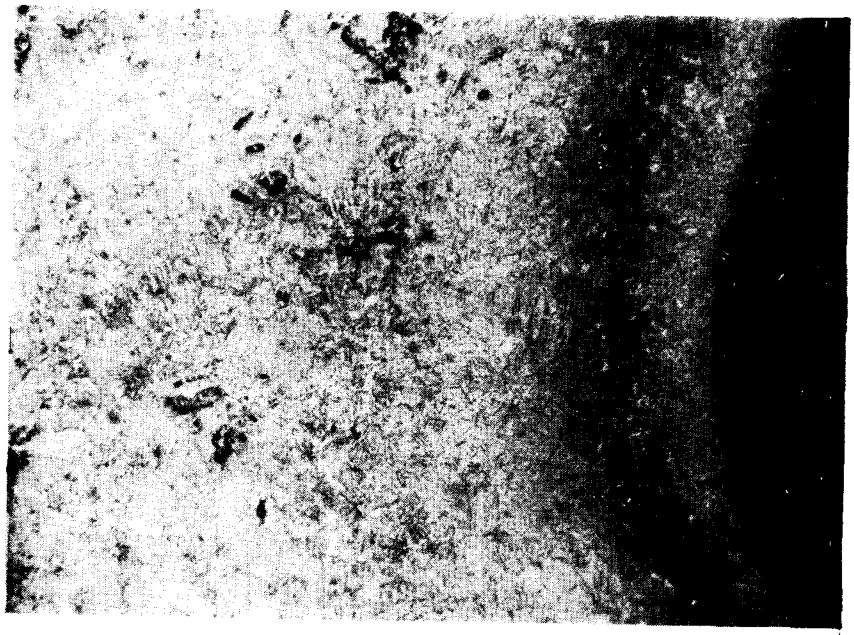

Figure 3. Microstructure of steel from roller x 50. A typical case-hardened (carburized) structure. The case is fine-grained lightly tempered martensite. The core is fine-grained bainite.

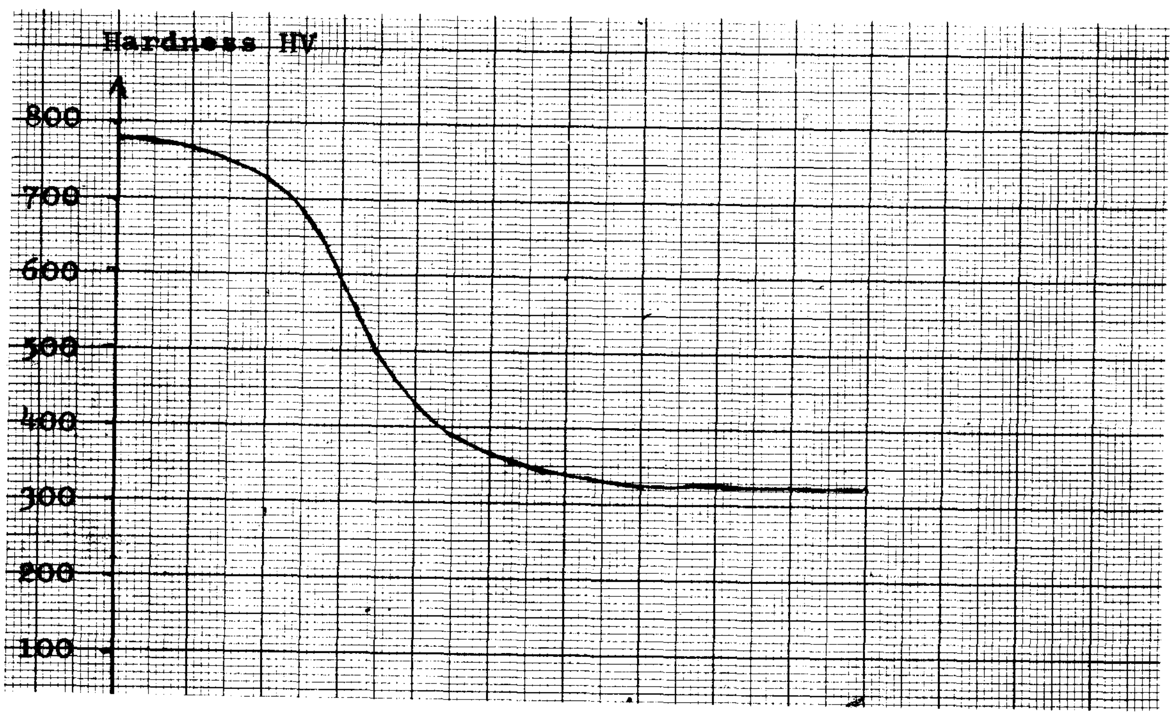

Figure 4. Hardness survey of case-hardened steel from roller.

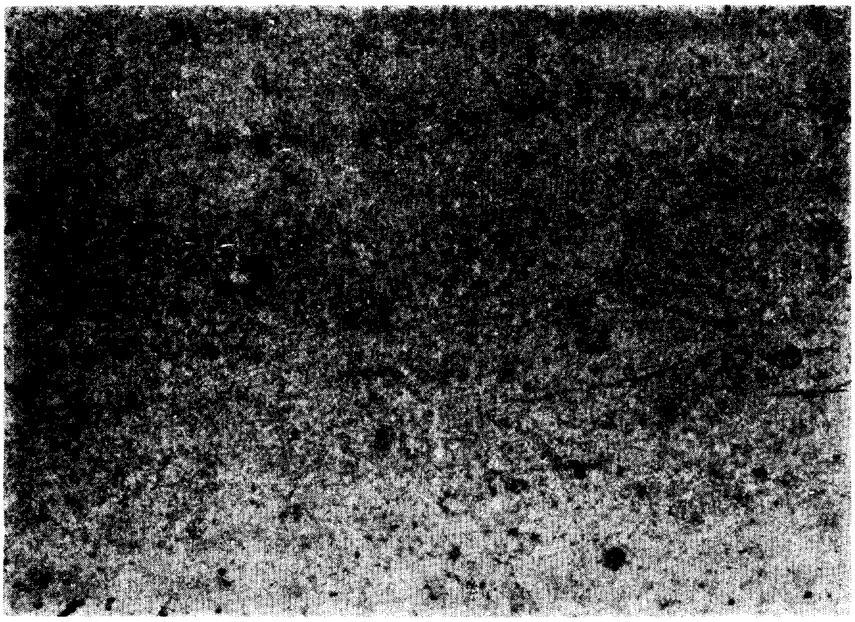

Figure 5. Microstructure of steel from die x 50. The structure is tempered martensite (sorbite) tempered at about 600°C.

for pelletizing places a high demand not only on the steel quality but also on the use of the die to prolong its service life. Localized excessive wear on the thin walled honeycombed design by abrasive contaminant of topioca could cause pieces of the die to break away, thus ending its usefulness as is evident in the case of the die shown in Figure 1.

CONCLUSION AND RECOMMENDATIONS

The die and rollers for pelletizing topioca can be manufactured locally provided suitable steels and heat treatment facilities are available. The rollers would preferably be imported at present as forgings but the die could be cast locally by a foundry such as the Siam Iron and Steel Company. Due to the somewhat complicated heat treatment which should be done by a specialist and the costly equipment involved for the production quantity required a detailed economic analysis is advisable before a decision is made to set up a local manufacture. However, based on the findings of the study the following manufacturing procedures may be recommended:

Rollers:	Steel composition:	0.2% C 1.0% Mn 1.0% Cr.
	Raw material:	Imported forged blanks.
	Machining:	Machine to size except hollow for shaft.
	Case hardening:	Pack carburize at 900°C for 12-16 hours.
		Grain refine 840-860°C oil quench.
		Harden 760°-780°C oil quench.
		Temper at about 300°C to obtain hardness case/core-750/320 HV.
Die:	Steel composition:	0.6% C 1.0% Mn 1.0% Cr.
	Raw material:	Casting (annealed and grain refined).
	Machining:	Machine to size.
	Harden:	800-850°C oil quench.
		Temper at about 600°C to obtain hardness 235 HV.