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## **Utilisation of Tannery Waste for the Manufacture of Animal Feed Products**

**Final Report**

**Westdeutsche Gerberschule Reutlingen  
Erwin-Seiz-Straße 9  
D-72764 Reutlingen  
Germany**

**10 November 1993**

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**Abbreviations**

Exchange rate USD / KSH	1 : 68
H <sub>2</sub> SO <sub>4</sub>	sulphuric acid
°C	degrees Centigrade
g/mol	gram/mol
pH	pH value
BOD	biological oxygen demand
COD	chemical oxygen demand
kWh	kilowatt hour
kW	kilowatt
bar	pressure in kg/cm <sup>2</sup>
sq-ft	square foot
l	litre
mg	milligram
UFL	UNGA FEED LIMITED

## **I. Introduction**

During leather manufacturing the following solid waste products are formed while the hides are in limed condition:

- \* fleshings resulting from the mechanical fleshing operation,
- \* trimmings from manual trimming of the pelts, and
- \* split waste useless for tanning.

Instead of referring to "waste", it is much better to use the phrase "by-products of leather manufacturing" when we discuss the above-mentioned products. This positive outlook on the material is necessary as a basis for studying the possibilities for utilisation of the constituents fat and protein.

In July 1992, the Tanners Association of Kenya requested UNIDO to explore technically and commercially viable possibilities which are presently available and affordable for the utilisation of tannery lime waste for the manufacture of animal feed. Three large tanneries in the vicinity of Nairobi generate an estimated 15-20 tons of lime waste per day. This waste is either hydrolysed and discharged into the tannery effluent, dumped into landfills or incinerated after drying. All these methods of disposal have a negative impact on the environment. A large local producer/importer of animal feed products has expressed his willingness to cooperate in close association with the tanneries in such a venture, provided the product derived from the tannery lime waste is of the required quality standards. Kenya is importing fish meal as an ingredient of animal feed products in large quantities. The local availability of a suitable substitute will contribute considerably to foreign exchange savings.

The main objectives of this study are the provision of specific information on commercially viable technologies to convert tannery by-products into animal feed products, safeguarding compliance with local required standards and the evaluation of the cost-benefit ratio.

## 2. Companies and plants in EUROPE where technologies to convert tannery lime waste into marketable products are employed.

All known companies in Europe were visited and their installations for the treatment of tannery lime were inspected. As far as the companies would allow us to do so, we gathered technical and economic data which are summarised in the following reports.

- 2.1 Company name:      **Consorzio S.G.S S.p.A.**  
                                   Via Nuova Francesca, 23  
                                   56029 S. CROCE SULL'ARNO (Pisa)  
                                   Italy  
 Date of visit:            25 June 1993  
 Name of inspector:      H. Zäpfel  
 Company contact:        Francesco Mori, amministratore delegato

220 interested leather companies of the region have joined forces in a cooperative in order to finance this plant. The only purpose of the plant is the processing of lime waste from the nearby leather factories.

The plant has a capacity of 100 tons of lime waste per shift. Work goes on in three shifts, which means that 300 tons can be processed per 24 hours.

### Products of the plant:

- ◇ protein meal 12%, 36 mt/24 h, sales price US\$ 0.50
- ◇ fat 9%, 27 mt/24 h, sales price US\$ 0.30
- ◇ hydrolysate, variable quantities according to demand, sales price US\$ 0.18
- ◇ filter cake 3%, 9 mt/24 h, for landfill disposal
- ◇ highly contaminated effluents to water treatment plant, about 228 m<sup>3</sup>/24 h

### Method

Both the method as well as the plant have been developed largely internally and in cooperation with several suppliers. The plant has been operated in its present form since 1982.

- ◆ The lime waste supplied by the leather factories is first of all ground mechanically (WOLF grinder).
- ◆ Afterwards it is boiled at 70 °C, and a rough separation from the fat is effected.
- ◆ In several stages, the fat is cleaned while adding H<sub>2</sub>SO<sub>4</sub>, until it is capable of being sold.

- ◆ The hydrolysate is collected in large drums and cleaned before it is concentrated until a 56% dry substance is reached.
- ◆ In a spray drying process, fine protein meal is produced from the hydrolysate which is then packed in sacks and sold.
- ◆ The effluent is pre-treated before it is allowed to enter the municipal water treatment plant. Any solid matter is then dewatered in a filter chamber press. The filter cake is then disposed on a landfill.

#### Commercial data

- ◆ The plant requires an investment of some US\$ 5 million excluding buildings.
- ◆ The premises are extended over an area of 30,000 square metres in total.
- ◆ The leather factories are required to deliver the lime waste free of charge and to pay a costs of US\$ 47.00 per ton for processing.
- ◆ The operation of the plant requires a workforce of 42 people in total. The plant is headed by a chemical engineer.
- ◆ The neighbourhood of the plant is affected by smells and odours.

2.2 Company name: Möller Werke, Lederfabrik  
Auf dem Kupferhammer  
D-4800 Bielefeld  
Germany

Date of visit: 05 July 1993

Name of inspector: Mrs. Renner

Company contact: Dipl.-Ing. Besserer

The company Möller-Werke disposes of a processing capacity of a maximum of 140 tons green weight, representing about 4000 cow hides per day. The company works as on a contract basis and produces wet blue and crust for its customers. The hides are provided by the respective customers.

All hides are fleshed after liming. There are therefore large amounts of fleshings and trimmings in the shape of lime waste.

As far back as 1984, a plant for the degreasing of lime waste was erected with a capacity of 4000 kg/h.

In the first few years of operation, the remaining hydrolysate was accepted by the water treatment plant of the town of Bielefeld. In the meantime, the plant has been extended. The hydrolysate is now boiled down and fed into the production process of other companies for the production of animal feed products.

## Method

Lime waste is fed directly from the fleshing machines into a collector drum. Netzsch Mohno pumps are used as conveyor pumps. Thus, the fleshing machines and the processing plant can work independently of each other. Trimmings are added without first being ground into the buffer container in the relevant proportion. From the buffer container, the lime waste is pumped into the dissolving tanks. The dissolving tanks are equipped with an agitator and are heated with the waste steam from production. There, the trimmings are dissolved at approximately 60 °C stirring constantly. The solution is pumped through a screen into a second dissolving tank. Special enzyme products of the company Röhm (Rohazym ML) are added there. Due to the enzymatic decomposition, protein hydrolysates with molar masses of less than 1000 g/mol are produced. The glue-stock is dissolved in batch operation. The following conditioning and separation work sequences are effected in throughfeed. The protein hydrolysate is acidified with sulphuric acid in the conditioning containers to reach a pH of approx. 4. In these agitation containers the temperature is kept to a constant 90 °C. The acidified hydrolysate is fed into a three-phase decanter. Here, the separation into fat, protein hydrolysate and solids is effected. The fat is pumped into a storage tank with a capacity of 40 cubic metres via a small intermediate buffer. Since 1988, the protein hydrolysate (dry matter = 9.5%) has been concentrated in a three-stage Wiegand evaporator to 50% dry matter and pumped into storage tanks from there. The solids are fed directly into troughs. The solid content amounts to some 35%.

## Products of the plant

The plant produces:

Fat:	approx. 150 kg per ton lime waste
Hydrolysate:	approx. 100 kg per ton lime waste with 50% dry matter for animal feed products
Solids:	approx. 40 kg per ton lime waste with 35% dry matter

## Commercial data

- ◆ Price of degreasing plant: approx. US\$ 1.3 million
- ◆ Price of plant for production of hydrolysate: approx. US\$ 0.6 million
- ◆ Space requirement for 150 square metres x three floors
- ◆ Steam and chemicals
- ◆ Human resources requirements: plant works mostly fully automatically.
- ◆ Exhaust air 5,000 cubic metres/h is used in the burner of the steam generator.
- ◆ The market value for fat amounts to US\$ 0.40 per kg at present.



- ✦ The plant works at break-even level, i.e. the revenue and costs balance each other out.

2.3 Company name: SÜDLEDER GmbH  
 Gerberstr. 44  
 D-8673 Rehau  
 Germany

Date of visit: 07 July 1993

Name of inspector: Mrs. Renner, Mr. Zäpfel

Company contact: Dr. Heinzig

SÜDLEDER processes approx. 75 tons (green weight) of cow hides per day. There are two different beamhouse operations.

Beamhouse 1:

The hides are fleshed before liming. The fleshings and trimmings are therefore not contaminated, and they are supplied to a company which produces fat and meat meal from slaughter-house waste.

Beamhouse 2:

The hides are fleshed after liming. The fleshings and trimmings therefore constitute lime waste to the amount of approx. 1200 kg/h or max. 10 tons/day.

This lime waste quantity can be used alternatively as follows:

- ✦ Supply to the company TROBAS, the Netherlands, for production of fat, glue and gelatine. SÜDLEDER is required to pay the freight costs to Holland and an additional US\$ 40,00 per ton as a contribution to the processing costs.
- ✦ Processing on a Flottweg plant.

SÜDLEDER possesses a plant for the processing of 1.5 tons/h of lime waste. This plant is described in greater detail in the Flottweg report under item 3.1. The plant can also be operated continuously in direct connection with the fleshing machine. The fat produced can be sold at a market price of at present US\$ 0.40.

Water and hydrolysate (protein phase) are fed to the water treatment system where they lead to a major source of contamination (large amounts of sludge, increased BOD value).

Measures for improvement are planned:

- ✦ Use of dryers for protein phase.
- ✦ Conversion to fleshing before liming.

2.4 Company name: ELMO-CALF AB  
 S-51281 Svenljunga  
 Sweden  
 Date of visit: 26 August 1993  
 Name of inspector: Mr. Zäpfel  
 Company contact: Hans Eierkus, Production Manager

ELMO processes approx. 50 tons of cow hides (green weight) into high-grade furniture leathers. All hides are fleshed after liming. As far back as 1979, ELMO invested in a plant for degreasing lime waste which is still used in the same way.

#### Specification of the plant

The plant consists of:

- 6 Fat extractors (containers) with a capacity of 3.2 cubic metres each with automatic control of the steam heating.
- 2 Fat cleaning tanks with a capacity of 4 cubic metres each with shell-type heating.
- 1 Sedimentation tank for protein/water with 10 cubic metres capacity

Various pumps and control units.

One operator is required for control of the plant.

Method, see ANNEX I

- ✦ The extractors are filled, whereby the fleshings are pumped directly into the extractor from the fleshing machine.
- ✦ As soon as one extractor is full, steam is fed in via a manifold at the bottom of the extractor.
- ✦ During a process period of approx. five to six hours the fat melts and is collected at the top of the extractor.
- ✦ By means of the addition of water, the contents of the extractor are lifted and the fat decanted off over the upper edge of the extractor.
- ✦ The fat flows into heated containers where small quantities of water and foreign bodies can sediment.
- ✦ Afterwards, without using separators, fat with good commercial quality and the following analysis is attained:

Setting point	24 °C
Acid value	0.1
iodine value	64
Water content	0,09 %
Saponification value	194

- ◆ The protein/water mixture is pumped out of the extractor into the sedimentation tank. The solids are then taken to a landfill, while the effluent is fed into the water treatment plant.

#### Current production data

- ◇ Lime waste per week: 125 cubic metres  
(inclusive of some water which is added during the fleshing process)
- ◇ 2 - 4 cubic metres of fat per week.
- ◇ Sales price of fat: US\$ 0.40 per kg.
- ◇ Protein phase for landfill: 25 to 35 cubic metres per week.
- ◇ Steam requirement: approx. 300 kg for each extractor load or approx. 0.1 kg steam per 1 kg lime waste.

#### Required capital investment

The current price of the unit would be US\$ 320,000.00. The output of the plant is determined by the number of extractors. It can be adjusted to the size of any leather factory so that the price of the installation can differ from case to case.

#### ANNEX I:

Schematic diagram of fat recovery from tannery lime waste.

2.5 Company name. Faaborg Garveri A/S  
Fruens Loekke I  
DK-5600 Faaborg  
Denmark

Date of visit: 23 August 1993

Name of inspector: Mr. Zäpfel

Company contact: Mr. Otto Dittmann, owner

This renowned Danish leather factory has a capacity of 900 cow hides daily. All fleshings/trimmings are transferred directly and automatically from the fleshing machine to a WOLFKING grinder (ANNEX 4); after grinding they are continuously pumped into a dewatering container with a capacity of 15 cubic metres (ANNEX 7). Together with other raw materials, the material is then fed into the process of a biogas plant. This plant is only approx. 20 km distant from the leather factory. Its inspection is described under item 2.6.

As tannery lime waste is useful in a biogas process, the material is fetched free of charge for the leather factory. No money is paid, however, for the material itself.

2.6 Company name: Bestyrelsesformanden i  
 Fangel Miljø- og Energieselskab a.m.b.a.  
 DK-5672 Broby  
 Denmark

Date of visit: 23 August 1993

Name of inspector: Mr. Zäpfel

Company contact: Mr. Peter Thügesen, works manager

This state-of-the-art biogas plant has been financed by 28 Danish farmers with the support of the government.

The plant runs fully automatically 24 hours a day. 160 tons of raw material can be processed within 24 hours.

In the month of April, the following raw materials were processed:

Liquid pig manure	2600 tons
Liquid cow manure	1500 tons
Liquid chicken manure	150 tons
Slaughter-house waste	620 tons
Sludge from water-treatment plants	50 tons
Old fat from deep friers	30 tons
Tannery lime waste	620 tons (approx. 1%)

It was pointed out that the quantity of tannery lime waste should not exceed 15 % of the total quantity of raw material.

It can be recognised that the plant is mainly used for the processing of manure. Tannery lime waste is, however, beneficial for the process sequence and is therefore accepted from the leather factories without hesitation.

#### Products of the plant

- ◆ The plant produces 9000 cubic metres of biogas in 24 hours with a methane content of more than 65%.
- ◆ An installed electricity generating plant, consisting of a gas motor and a generator, produces more than 11,000 kWh/24 h.

#### Commercial data

- ◆ Buildings, plant inclusive of vehicles for LOGISTICS are worth US\$ 6 million.

- ◆ The premises extend over 17,000 square metres in total.
- ◆ The plant is controlled by one operator (daytime only), 1 fitter (part-time) and two truck drivers.
- ◆ The market-price for 1 kWh for private customers is US\$ 0.18. Electricity generation by the plant is subsidised to the level of US\$ 0.06/kWh by the state.
- ◆ The residual products of the plant can be used 100% as fertilisers.
- ◆ The plant produces no emissions to the environment whatsoever; there is no smell.

2.6 Company name: Different leather factories in EUROPE, e.g.:

- \* Lederfabrik Ichenhausen, Ichenhausen, Germany
- \* SÜDLEDER Werk 2, Rehau, Germany
- \* Amsterdamsche Huidenclub, Nijmegen, Holland

Date of visits: June to September 1993

Name of inspector: Mr. Zäpfel

Company contacts: Managing directors

The mentioned companies are good examples of a new method of leather production which is used more and more frequently in Europe and which experts hail as the "technology of the future".

- ◆ The hides are fleshed immediately before the liming process and not afterwards, as was previously the norm.  
Due to this modification, advantages are achieved not only for the utilisation of by-products but also for leather production itself.
- ◆ Advantages for the utilisation of by-products:
  - These by-products are not contaminated but fresh and of the same quality as other slaughter-house waste.
  - By-products from tanneries can therefore be processed by the same companies which also process slaughter-house waste, i.e.
    - + into commercial meat meal and
    - + animal fat.

As slaughter-house waste is generated in much higher quantities than tannery by-products, in every country several so-called "rendering plants" for the production of fat and meat meal from slaughter-house waste exist. The leather factory therefore has alternative possibilities for the supply of the by-products.

- ◆ Advantages for leather production itself:
  - The weight of the hides for the liming process is about 20% lower. Therefore, more hides can be limed in the same drum. The chemical and water requirement per hide is reduced correspondingly.
  - The result of the liming process is more uniform because the chemicals can enter the hides more evenly and easily from the flesh side.
  - The handling of the non-limed hides is much more pleasant for the staff.

2.8 Company name: LIJMFABRIEK TROBAS B.V. - THE NETHERLANDS  
Steenstraat 9  
P.O. Box 14  
5100 AA Dongen  
The Netherlands

Date of visit: No visit was allowed.

TROBAS is a producer of environmentally safe and biodegradable hide glue, technical gelatine and animal grease.

Our request for an inspection of the company was answered as follows:

"On principle, Trobas is not interested in divulging its technology for the utilisation of hide waste.

At the same time, our plant and the technology used in the same requires a large capital investment which makes it unsuitable for developing countries.

We therefore believe that your visit to our company would not make sense and regret having to refuse your request."

The company accepts large quantities of lime waste from large leather factories in Western Europe. The material must be supplied free of charge to TROBAS. In addition, the leather companies are required to pay an additional US\$ 38 to 44 per ton of lime waste to TROBAS.

### 3. Companies manufacturing important components for the processing of tannery lime waste

3.1 Company name: Flottweg GmbH  
 Industriestraße 6-8  
 D-8313 Vilsbiburg  
 Germany  
 Date of visit: 15 July 1993 in Reutlingen  
 Name of inspector: Dr. Germann, H. Zäpfel  
 Company contact: Peter Ecker, Deputy Sales Manager

The company Flottweg disposes of a great deal of experience in the processing of slaughter-house waste. It makes use of a thermal-mechanical process.

Flottweg has also applied this process to the processing of tannery lime waste and supplied 1 plant each to a large German and Austrian leather factory. At the request of both companies, the plant was designed exclusively for the degreasing of lime waste so that its high fat content of approx. 12% does not enter the waste water treatment plant.

The protein phase is not utilised in any way but fed into the existing effluent cleaning system.

#### Important:

- ◇ The company envisages the production of protein meal by using a suitable dryer.
- ◇ The plant will shortly be used also for the processing of non-limed fleshings and trimmings.

#### Plant capacities and Specifications

Type of plant	Output/h	Decanter	Inst. electrical load
LS-23	1.0 - 1.5 t	Z23-3/441	20 kW
LS-33	2.0 - 3.0 t	Z32-3/441	33 kW
LS-43	4.5 - 6.0 t	Z4D-3/441	44 kW
LS-63	10.0 - 12.0t	Z62-3/441	100 kW

Consumption figures

Steam:	max. 3 bar, 250 kg/t
Electricity:	60% of installed load, approx. 5 - 8 kWh/t (depending on plant size)
Operating staff:	2 - 3 operators/h per shift

## Investment costs:

Depending on the size and equipment the investment costs amount to US\$ 320,000,00 to US\$ 500,000.00.

## ANNEX 2:

Schematic diagram of the Flottweg plant

## ANNEX 3:

Analyses of long-term trials on a Flottweg plant

3.2 Company name: Gafert GmbH & Co KG  
 Postfach 44  
 D-24963 Tarp  
 Germany  
 Date of visit: 20 August 1993  
 Name of inspector: H. Zäpfel  
 Company contact: Mr. Gafert, owner

Gafert is the major supplier of grinding machines of the type WOLFKING DENMARK in Germany. These machines are used mainly for grinding meat; they have, however, also proved useful for the grinding of fleshings and trimmings of raw or limed hides. The ground material can be dewatered continuously using a worm extruder until 35% dry matter is attained. In this state, the material can be transported economically:

- to the company for the production of meat meal;
- to a farm for direct addition to animal fodder.

A much simpler solution is the use of a dewatering container. This is a standard transport container which fits onto a vehicle. For dewatering, a special screen is installed as filter basket. Dewatering is effected by means of gravity. If the period chosen is sufficient, the material is reliably dewatered.



If the material is to be degreased or if an additional sterilisation process is required, the grinding machine can be supplemented by a so-called melting or cooking pipe. The fat contained in the by-products is melted down. At the same time, a large amount of the bonded water is released so that a favourable concentration of the protein contents for the next processing stage is attained.

#### **ANNEX 4: GRINDER**

Supplier:

- 4a: WOLFKING, DENMARK
- 4b: SIMO MINCER, UNITED KINGDOM
- 4c: ALFA-LAVAL, DENMARK

#### **ANNEX 5: GRINDER in combination with MELTING/COOKING PIPE**

Supplier:

as under 4a-c

#### **ANNEX 6: DEWATERING-PRESS**

Supplier:

- 6a: PONNDORF, GERMANY
- 6b: SAILER, GERMANY
- 6c: PICATECH, SWITZERLAND

#### **ANNEX 7: DEWATERING CONTAINER**

#### 4. Visits to tanneries in Kenya

During the week from September 20 to the 25th of the same month a group of tanneries in Kenya was visited in order to make a survey of the way these tanneries were trying to solve the problem caused by industrial waste. This survey was carried out by Dipl. Ing. Horst Zäpfel from the Gerberschule Reutlingen and Dipl. Ing. Augusto Zink working under project US/RAF/92/200 as Machinery Maintenance Expert and in this specific case, assisting Mr. Zäpfel.

The following tanneries visited were the following:

- 4.1 Company name: Kamiti  
Company contact: Mr. Opio, production manager

This tannery has recently changed ownership and will be restructured. The new management has bought machines and drums to restart production. The new owner is Mr. Aboub Adoud, a well-known hides and skins merchant in Kenya. Most probably this tannery will work first leathers and skins up to the stage of wet-blue. Planned production is 1000 hides a day (20,000 kg wet salted). Work will also start on skins, but at this moment work can already start with hides up to wet-blue.

##### Lime waste:

As all hides and skins are fleshed after liming there are corresponding quantities of lime waste. The fleshing machines are set up in such a way that the fleshings can slide through the external wall of the tannery into a prepared wood drum. In order to guarantee a reliable conveyance of the fleshings into the drum, a lot of water is added during the fleshing process, (approx. 20 to 30 cubic metres/day) which leads to the following disadvantages:

- ◇ excessive water consumption;
- ◇ additional generation of effluents.
- ◇ fleshings and water must separated again.

The lime waste is then reloaded into a single-axle cart with a capacity of 3.5 cubic metres. The cart leaks, and the escaping effluents therefore soil the streets in the residential areas.

4.2 Company name: Bulleys Tannery, Thika  
Company contact: Mr. Kinya, Production manager  
Mr. J.G. Kahiu, Managing director

Capacity: 2000 cow hides/day and 12000 goatskins/day  
Current production levels: 700 cow hides/day and 6000 goatskins/day

The raw material is dried in the sun.

Dry weight x 2.6 = Soak weight

e.g. 5.5 kg dry weight x 2.6 = 14.3 kg soak weight

On average, the cow hides provide a leather surface of 26 sq. ft.

Process features relevant for the waste products:

- ◇ Goatskins are trimmed in a dry state. There are large amounts of dry skin cuttings.
- ◇ Hides and skins are fleshed after the liming process. There is a corresponding quantity of lime waste.
- ◇ Hides are split after tanning. There are large amounts of cutting waste from the chrome splits.

A lively discussion was held on the advantages and disadvantages of splitting after liming instead of splitting after chrome tanning.

Details of this discussions are contained in the conclusion (item 7). A separate investigation would have to show whether goatskin waste could be utilised in a beneficial way. A lively discussion was also conducted on the advantages of fleshing before liming (green fleshing). Details of this discussions are contained in the conclusion (item 7).

Lime waste:

The fleshings which are mixed with a great deal of water "float" into a boiling tank where the fat and water is separated from the solids which are cooked for some hours and then discharged as solid waste. The fats are going this way to the effluent already diluted and with collagens in form of liquid. Huge amounts of diesel-oil are needed to heat the tank.

- 4.3 Company name: Leather Industries of Kenya LTD  
 Company contact: Mr. Amin Kassau, General Manager  
 Mr. C.R. Venugopal, Production Manager

Current production levels: 1200 cow hides/day, 3000 goatskins/day.

- ◇ All fleshing after liming process.
- ◇ Splitting after chrome tanning.

The company produces mostly wet-blue and only little finished leather.

Lime waste:

The fleshings "float" into prepared containers. The trimmings are also collected in a container. The whole lime waste is currently boiled down completely in a concrete pit. The fat floating at the top is "scooped off", and the whole of the remainder consisting of water, hydrolysate and residues is fed in the waste water treatment plant.

The energy requirement is very high but could not be stated precisely. The water treatment plant is sufficiently large to accept the lime waste. The sludge is dried in large "drying beds" before being taken to a landfill.

There was an interested discussion on whether less water or no water whatsoever should be used during the fleshing process.

As the fleshing machine is very usefully placed on a 2 m high pedestal, the fleshings can be gravity fed into a special fleshing pump from where they are conveyed in pipes up to 200 metres. (Possible Supply: Type FLECO of KRAUSE/CLASEN, Type 2NS80 of NETZSCH.)

- 4.4 Company name: ALPHARAMA LTD.  
 Company contact: Mr. Rao, Production Manager

Capacity: 1500 cow hides/day and 6000 goatskins/day

The cow hides have an average soak weight of 16 kg and a leather surface of 27 sq. ft. All hides and skins are fleshed after liming. The quantity of lime waste is indicated at 5 tons/day.

The splitting process is carried out after tanning which leads to large amounts of chrome-tanned waste. There are no concrete plans for introducing splitting after liming.

The lime waste "floats" with a great deal of water through a wooden channel at the outside wall of the tannery. The solids are laboriously "fished out" of the water and

collected in a wooden drum with a diameter of approx. 2000 mm. Then steam is added and everything is boiled down.

Approx. 80 to 100 m distant there is a sedimentation basin with the dimensions 4 x 4 m and 0.8 m depth.

The water is drained off, the solids dry and are then incinerated.

This waste of water and the painful separation of fleshings and water could easily be avoided altogether by using fleshing conveyors (see report 4.3). The group has tanneries in Kenya, Nigeria and Sudan.

- 4.5 Company name: Babar Tannery  
Company contact: John Itumo, Production Manager

This tannery can only work up to wet-blue, because they have no finishing machines. Their capacity is 1000 hides and 9000 skins, and this generates 5000 kg of lime waste that is soaked and then thrown into the yards to dry. When it is dry, people burn it. An effluent plant is operational for effluents.

- 4.6 Company name: BAWAZIR TANNERY LTD.  
Company contact: J.J. Dass, Leather technologist

This tannery is new and has not yet started working. It is designed to work 1000 hides and 7000 skins a day and at least 35% of the total production up to finished leather. The effluent plant is dry and the hides are only kept in store rooms. According to the planned production, the lime waste to be generated is going to be 5000 kg. and there is no envisaged solution about what to do with this waste.

- 4.7 Company name: AZIZ DIN  
Company contact: Aziz Din, Tannery Owner

This is one of the few tanneries working with indigenous raw materials such as mimosa and wattle extract for tanning. The production is 250 hides (cows and camels) and 1500 skins a day. The lime waste does not exceed 1 ton a day.

This lime waste is mostly obtained at the fleshing machines and remains for some hours after fleshing in such a way that its own weight presses water out. Once no more water is flowing out, the fleshings are carried on a buggy into a container situated in the street at the entrance of the factory. Once this container is filled up,

the city council service takes it away and dumps the waste in a landfill. Costs for this service: US\$ 17 per month.

- 4.8 Company name: DERAS LTD.  
 Company contact: George Alexandrakis, Managing Director  
 Nicolai, Production Manager  
 Carlo

This group has three tanneries in Nairobi area. The production of these factories is roughly 1000 sheep, 2500 goats and 1000 hides a day. The lime waste generated amounts to 4000 kg a day, and after fleshing these flays are carried to a pit where water is pressed out by their own weight. Once the water is out, this material is loaded into a truck and carried to be dumped to the place indicated by the city council. Payment per truck: US\$ 1.50.

- ◇ An interested discussion started on the question of fleshing before liming (green fleshing). A new POLETTO fleshing machine has been acquired, on which tests will be carried out shortly.
- ◇ A discussion was held about the pros and cons of splitting after liming instead of splitting after tanning.

- 4.9 Company name: Bata, Limuru  
 Company contact: Mr. Fernandez, Managing Director  
 Mr. Gigante, Tannery Manager

Bata works 1000 hides a day and approximately 4000 kg. of lime waste (incl. water) comes out of the fleshing machines. This material is pumped by means of a sludge pump into a pit where it is boiled with steam. The solids are dumped afterwards and the fat is separated. Some diluted fat with collagens flows into other pits for further treatment with the rest of the effluent.

- ◇ The sludge pump used here can only fulfil its function after the lime waste has been diluted with a great deal of water.
- ◇ This disadvantage can be removed by means of a special fleshing conveyor (see report 4.3).

#### 4.10 Total availability of solid lime waste

In the background information provided by UNIDO, a total amount of solid lime waste generated by the tanneries around Nairobi of 40 tons per day is mentioned. On the basis of the above tannery industry, it must be assumed that 40 tons is the maximum amount and that it is composed of a mixture of lime waste with approximately 25 % of water. It should also be taken into consideration that the fat content of this lime waste is much lower in comparison to European empirical values:

- ◇ African animals and hides contain less fat.
- ◇ The fat sticking to the hides is cut off when the hides are air dried.

Estimates:

40 tons of limes waste per day less 25% water correspond to 30 tons of solid lime waste per day.

Out of this:

5 % or 1.5 tons of fat per day

12% or 3,6 tons of dried protein meal/day

## 5. Visit to companies in Kenya dealing with animal feed products.

5.1 Company name: MIRITINI LTD.  
Company contact: Dr. J.G. Khiu, Manager, Veterinary Division  
(meeting at BULLEYS TANNERY)

Dr. Khiu provided us with the following statement:

### "PROTEIN RECOVERY FOR ANIMAL FEED

#### Review of market and supply conditions

Local meat and bone meal and blood meal is no longer available since the only source, Kenya Meat Commission has closed down.

Imported meat and bone meal with average 25-55% protein content is currently costing USD 421.00 per MT ton C/F Mombasa and 10% duty + handling, a total of 505.20 USD per MT ton. Average cost of the Tannery Animal Feed Protein would be 0.37 USD per kg<sup>1</sup>.

The present livestock feed industry ranges from small to large scale operators which is easily identified by their varying installed capacities. In 1970 there were about 10 feed mills but by 1986 the number had increased to 27 and this number has steadily risen and may be about 40 today.

The installed capacity of mills is approximately 400,000 MT per annum. The majority of the millers are located in Nairobi, Nakuru and Mombasa.

The table below presents the installed capacities for the main millers.

As is evident, Unga Feeds Limited is the dominant miller, accounting for 50% of the total production followed by Milling Corporation of Kenya.

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<sup>1</sup>Note by Mr. Zäpfer: MIRITINI apparently believes that USD 0,37/kg is the market price for protein meal generated from lime waste. The production costs are much higher, however.



<b>FEED MILLERS</b>	<b>LOCATION</b>	<b>CAPACITY (MT TONS)</b>
1. Unga Feeds	Nakuru	150,000
2. Unga Feeds	Nairobi	40,000
3. Milling Corporation of Kenya	Nakuru	40,000
4. Muus	Thika	30,000
5. Moore Industries	Nairobi	30,000
6. Atta Limited	Mombasa	20,000
7. A.B.C. Foods	Nakuru	12,000
8. Belfast Millers	Nairobi	10,000
9. Kitale Industries	Kitale	8,000
10. Ideal Manufacturers	Nairobi	5,000
11. Sigma Feeds	Nairobi	5,000
12. Merchant Manufacturers	Nairobi	3,000
<b>TOTAL</b>		<b><u>353,000</u> MT TONS</b>

The feed industry utilises maize, wheat, barley, oats, millet and other available cereals which are blended with oil-cakes and animal by-products such as fish, meat and bone meal, and blood meal.

The animal protein accounts for 30 percent of the costs of both poultry and pigs.

The recommended protein content in the feeds according to the Kenya Bureau of Standards is:

Pig feeds	-	12-17%
Cattle feeds	-	14-18%
Poultry feeds	-	15-25%

If it is assumed that the overall average is 16%, then for 400,000 MT tons of feed a total of 64,000 MT tons of protein is required annually which, if 50% is animal based will be 32,000 MT tons annually."

- 5.2 Company name: Unga feeds Limited  
 Company contact: D.H. Farthing, Manager, Veterinary Division

Mr. Farthing informed us that some years ago they got some samples of tannery waste to be analysed for the possibility of utilization in animal feed production. The results

were negative as the analysed samples showed too high values of salt and chrome. This is something that happens when the samples are really considered as wastes and not as by-products. In all the meetings held with different tanners, it was important to highlight that we are not dealing with wastes but with by-products that with proper handling can be transformed into digestive proteins, fat or fertilisers. In case of fleshings/trimmings the usual result of analyses in Europe indicate 60%-69% of proteins with 95% to 96% digestibility. Sometimes this material contains water and chemicals. The usual product used in the tanneries at this stage is sulphides but they oxidise during drying. The main problem could be then, if the amount gathered from the different tanneries would be enough to justify the expenditure of a processing plant. If the calculated amount provided by the tanneries in Nairobi and surroundings reaches 40 tons, after drying there will be only 8 tons dry material left as 80 % of it is water. On the other hand it would be a pity not to utilise this source of proteins. The best protein value from soya meal does not exceed 45% to 50%. The problem of Unga feeds Limited at this moment is that they have spent much on a new plant and there is no interest to spend more money at this moment, but they would be interested in buying the meal if somebody else produced it.

The conclusion of this meeting was, that if only tanneries were considered as a source of raw material, the end product would hardly amount to more than 6 tons a day. It was suggested that there might be a possibility to employ abattoir offal in order to increase the raw material. This is not possible at this moment as activities with abattoirs are not included in our program. It was also mentioned that UFL is using bone meal to the extent of about 200-400 tons per month.

This important meeting has made the following facts clear:

- ◆ UNGA feeds can only utilise protein meal but not lime waste for its animal feed products. Tanneries therefore require their own plant in order to process lime waste into protein meal.
- ◆ UNGA feeds is interested in buying daily quantities of 6 tons of protein meal produced from lime waste. Price: approx. US\$ 460.00/ton.
- ◆ Slaughter-house waste is not processed in Kenya, and there are no "rendering plants". Unlike their counterparts in Europe, tanneries in Kenya therefore cannot supply their fleshings and trimmings to a rendering plant for the production of meat meal.
- ◆ UNGA feeds sells all its production within Kenya. The requirements for poultry farmers is highest at 70%.

## **6. Visit to government authorities**

### **6.1. Ministry of Water Development**

**Contacts: Mr. Weru, Assistant to the Minister**

This ministry is concerned in the survey that was carried out in order to analyse the feasibility of this project utilising tannery lime waste, but was also looking at it in a very positive attitude, as this project, if carried on the proper way, could ameliorate the pollution effect caused by this waste. The same worry arose regarding the small amounts of raw material available, and the suggestion to utilise abattoir offal was mentioned. The idea is good, but again it goes beyond the parameters that are established for this UNIDO project. As the question arose of the possibility to involve the ministry, the answer was similar to the reason of our constraints, that the Water Development Office is not involved with abattoirs. Despite these limits, if the UNIDO expert writing this report is authorised to visit an abattoir, the person visited at this ministry will accompany him. Despite these limitations on both sides, it was known that in f.e. Dagorethi Market abattoir, bones and hooves are used for making bone meal. Blood is apparently washed away and there is no proper sewage system. This could not be established, as we did not visit the place, but if this is true, there will be many things abattoirs will have to improve before they get involved in this type of project.

### **6.2. Ministry of the Environment and Natural Resources**

**National Environment Secretary (NES)**

**Contact: Mr. Kihuma**

This office is in charge of coordinating ministerial departments with international organisations and is in some form involved with environment and the leather project concerning effluent treatment and pollution. Some ideas similar to the ones mentioned before were brought forward and also the possibility of utilising fish meal factories, as apparently the procedure UNIDO was looking for was similar. It was explained that trials were done but the type of dryer was not appropriate and the glue sticks around the internal walls of the oven and cristalizes making it difficult to take it out.

## 7. Conclusions

Discussions in a round-up meeting (Annex 15) were very lively and constructive. The conclusions can be summarised as follows:

- 7.1 Lime waste can be called a by-product because its constituent parts can be used in a purposeful way, e.g. for the production of animal feed products.
  - Protein meal (ANNEX 8)
  - Fat (ANNEX 9).
- 7.2 Protein meal and fat can be sold in Kenya at a market value of US\$ 460 per ton of meal and US\$ 600 per ton of fat.
- 7.3 Due to the different animal races, due to different breeding methods and due to the fact that a part of the fat is cut off during air drying of the hides, the lime waste in Kenya contains less fat than lime waste of European hides.  
Estimate: 5% fat and 12% protein meal.
- 7.4 The processing of lime waste should not only be seen under the aspect of the benefit from the sale of meal and fat. The ecological aspect is also of importance. In Europe, some tanneries pay a contribution of US\$ 47 for every ton of lime waste for its processing.
- 7.5 The avoidance of lime waste by means of fleshing before liming (green fleshing) is gaining increasing importance in Europe. Green fleshing waste can be processed together with slaughter-house waste in fat and meal production plants which exist in many places.  
With this future-oriented method there are additional advantages for leather production:
  - The weight of hides for the liming process is approx. 20% lower. In the same drums, more hides can therefore be limed. Chemical and water requirement per hide is also reduced accordingly.
  - The result of the liming process is more uniform because the chemicals can enter the hides more evenly and easily from the flesh side, and the fibres can also be loosened during the fleshing process.
  - The handling of the non-limed hides is much more pleasant for the staff.
- 7.6 In Kenya slaughter-house waste is not organised or collected systematically for processing. There are probably no processing companies for the same.

7.7 Nevertheless, tanneries in Kenya are interested in introducing green fleshing:

- because of the advantages for leather production;
- because of the possibility to possibly only grind green waste and to feed it into the animal feed production process without elaborate drying and degreasing.

7.8 The decision in favour of green fleshing in Kenya requires development of European know-how so that it can be adapted to conditions in Kenya. The following are important points to consider in this context:

- Modification of fleshing machines.
- Preparation of hides and skins which are sun-dried by 80%.
- Analysis of fleshings with a view to a direct use as animal feed.

7.9 In case of green fleshings, the green waste of tanneries in Kenya can be processed as shown in ANNEX 12. As this is a rather straightforward plant which requires relatively little investment, it was possible to install several plants in several tanneries. Provided that the regional locations are selected favourably, short transportation routes for the green fleshings could be achieved in this way.

Estimates for processing green fleshings/trimmings from Kenya hides assume approx. 2000 kg of green fleshings per hour.

Plant according to ANNEX 12: Investment for items 2.01 to 2.04: USD 150,000.00.

Installed power: 40 kW

People employed: 1 - 2

Products: \* 800 - 1000 kg/h solids with a dry substance of about 25% to be used as animal feedstuff. The daily collection of the material by the nearby poultry and pig farms has to be organised.

\* 1000 - 12000 l/h waste water (COD 10,000 mg/l).

7.10 A joint installation of the tanneries in Kenya for the processing of lime waste into protein meal and fat would, on the other hand, involve a much higher capital investment. With a processing quantity of not more than 40 tons lime waste per day and the high energy requirement, the installation would not work above break-even level. It would therefore be necessary to charge the tanneries for the processing of lime waste in very much the same way as applied in industrialised countries (USD 47 per ton of lime waste).

Estimates for processing of lime waste (fleshings/trimmings) from Kenya hides assume approx. 30 - 40 tons of lime waste per day.

Estimates for processing of lime waste (fleshings/trimmings) from Kenya hides assume approx. 30 - 40 tons of lime waste per day.

Plant according to ANNEX 2 or ANNEX 13, in addition with dryer according to ANNEX 14.

Investment:

Items 2.01 to 2.13 (cf. ANNEX 2) USD 370,000.00

Dryer for solids (ANNEX 14) USD 300,000.00

Installed power: 70 kW

Steam consumption:

For item 2.02, steam of 140 °C: 5.0 mt/day

For the dryer, steam 8 bar: 10 mt/day

People employed: 2

Products:

\* Fat 1.5 - 2.0 mt/day

\* Protein meal 3.5 -5.0 mt/day

\* Waste water 25 cbm/day

(COD 70,000 mg/l)

7.11 Irrespective of the method used to process the fleshings and trimmings, the water consumption during the fleshing process can be reduced and the internal handling can be improved (ANNEX 10, ANNEX 11).

7.12 For the large quantities of chrome-tanned waste no purposeful utilisation can be suggested.

By means of a change in leather production - splitting after liming - it would be possible to also utilise splitting waste purposefully.

According to the experience available the following advantages in leather production could be attained:

- Higher area yield in the case of grain leather (approx. 5%);
- more even tanning because a defined hide thickness is tanned;
- reduction in the use of tanning agents, as no waste is tanned;
- reduction in the amount of chrome in effluents, as with a defined hide thickness the exhaustion of the chrome float can be controlled more closely (use of low chrome tanning).

In contrast to this, there are the following disadvantages:

- Modification of current chrome splitting machines into lime splitters;
- development and introduction of the know-how necessary for lime splitting.

**7.13** When air-dried goatskins are cut, large quantities of dry waste is generated. Separate research will be necessary to determine whether a purposeful utilisation is possible.

**7.14** Without a doubt, tanneries in Kenya will have to increase their expenditure in order to solve ecological problems. For this reason, too, the value-added of the raw hides should be increased by:

- production of crust and finished leather instead of wet-blue (value-added 30% only);
- production of working gloves instead of selling wet-blue splits to Taiwan for production of working gloves for export.

## 8. Recommendations

### 8.1 Processing of green waste:

The operation of several plants is suggested according to item 7.9 and ANNEX 12 in leather factories located centrally within their regions. A condition is the introduction of the green fleshing method (fleshing before liming) in Kenya. Know-how available in Europe must be transferred in the context of a systematic "adaptation development" to the situation in Kenya:

8.11 Preparation of the sun-dried African hides for green fleshings.

8.12 Modifications of fleshing machines. This is likely to be easier to carry out than in Germany as African hides are much lighter and have less manure attached.

8.13 Analysis of green fleshings and trimmings of African hides and assessment with a view to their use as animal feed products.

8.14 Organisation of cooperation between the leather factories and animal farms in Kenya.

8.15 As a follow-up of this survey it is therefore recommended that about 150 hides of African origin (sun-dried) are processed at a suitable place.

### 8.2 Processing of lime waste

In this case a joint installation of the tanneries in Kenya according to item 7.10 and ANNEX 2 or ANNEX 13, combined with a dryer according to ANNEX 14, is to be operated.

### 8.3 It does not matter if green or lime fleshings are applied:

It is suggested to modify the positioning of the fleshing machine in the leather production sequence according to ANNEX 10 or ANNEX 11. By doing so, important advantages can be realised:

- ◆ Saving of large quantities of water and waste water as the fleshing process can be carried out without the addition of any water or with the addition of only very little water.
- ◆ Considerable improvement of the operating environment. The fleshings/trimmings run into the transport containers without manual handling. When a pump is used, the fleshings/trimmings can be conveyed in pipes up to 200 m.
- ◆ Improved material flow. In front of the fleshing machine there are only unfleshed hides. Without any interruption to the production process, new hides can be provided.



Behind the fleshing machine the fleshed hides are trimmed and taken away. This process can also be effected continuously without any interruption to the production process.

The fleshing machine can be set up at a spot which is favourable for the production flow of the hides (e.g. in the centre of the building), instead of at the outside wall of the building, as has been mostly the case in the past, because the waste had to be flushed through the outside wall with a great deal of water.

## **9. Appendix**

### **ANNEX 1:**

**Schematic diagram of fat recovery from tannery lime waste**

### **ANNEX 2:**

**Schematic diagram of the Flottweg plant**

### **ANNEX 3:**

**Analyses of long-term trials on a Flottweg plant**

### **ANNEX 4:**

**WOLFKING UNIVERSAL WOLF GRINDER**

### **ANNEX 5:**

**WOLFKING GRINDER in combination with MELTING/COOKING PIPE.**

### **ANNEX 6:**

**DEWATERING PRESS**

### **ANNEX 7:**

**DEWATERING CONTAINER**

### **ANNEX 8:**

**Analyses of protein meal from lime waste on the basis of South German hides**

### **ANNEX 9:**

**Characteristics of fat from lime waste on the basis of South German hides**

### **ANNEX 10:**

**Fleshing machine on a platform, fleshings are fed into a dewatering container by gravity**

### **ANNEX 11:**

**Fleshing machine on a platform, fleshings are fed into a fleshing pump by gravity**

### **ANNEX 12:**

**Schematic diagram of the green waste processing operation**

**ANNEX 13:**

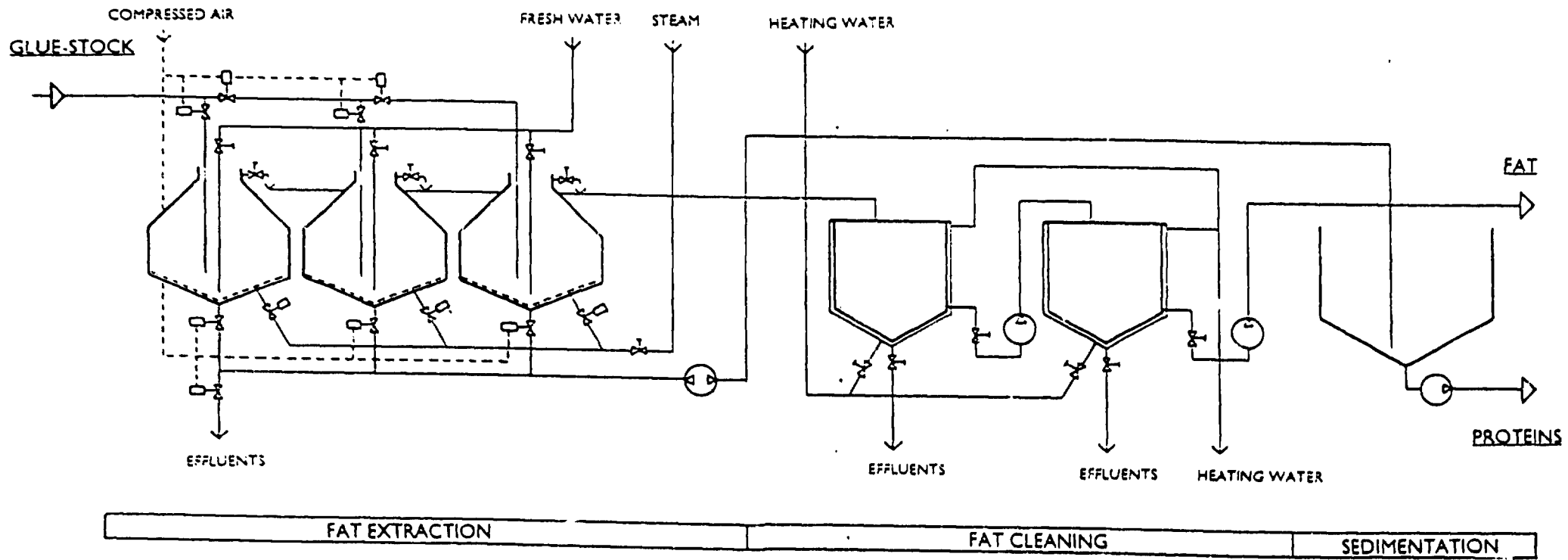
**Schematic diagram of the Alfa Laval plant**

**ANNEX 14:**

**Dryer for greaves (solids) from the decanter**

**ANNEX 15:**

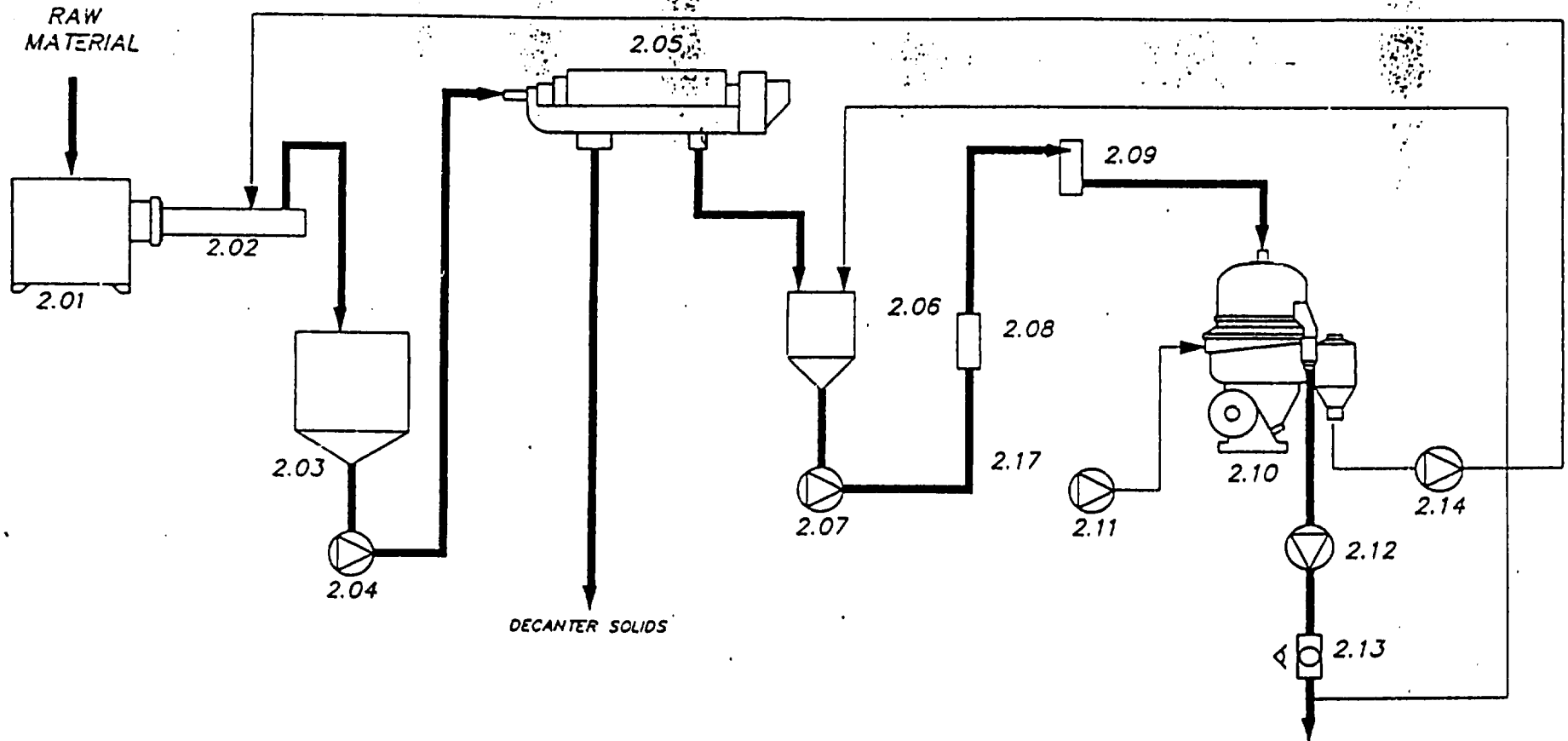
**Round-up meeting in Kenya**



**ANNEX 1:**

Schematic diagram of fat recovery from tannery lime waste

# CENTRIFLOW PLANT



- |                           |                           |                                      |
|---------------------------|---------------------------|--------------------------------------|
| 2.01 RAW MATERIAL MINCER  | 2.08 STEAM HEATER         | 2.16 ELECTRIC CONTROL PANEL          |
| 2.02 MELTING TUBE         | 2.09 DE-AERATION CYCLONE  | 2.17 SET OF PROCESS PIPES AND VALVES |
| 2.03 INTERMEDIATE TANK    | 2.10 SEPARATOR            |                                      |
| 2.04 FEED PUMP            | 2.11 OPERATING WATER PUMP |                                      |
| 2.05 DECANTER             | 2.12 FAT PUMP             |                                      |
| 2.06 INTERMEDIATE TANK II | 2.13 CLARITY CONTROL      |                                      |
| 2.07 FEED PUMP            | 2.14 SLUDGE PUMP          |                                      |

ANNEX 2:  
Schematic diagram of the Flottweg plant

## ANNEX 3:

Analyses of long-term trials on a Flottweg plant

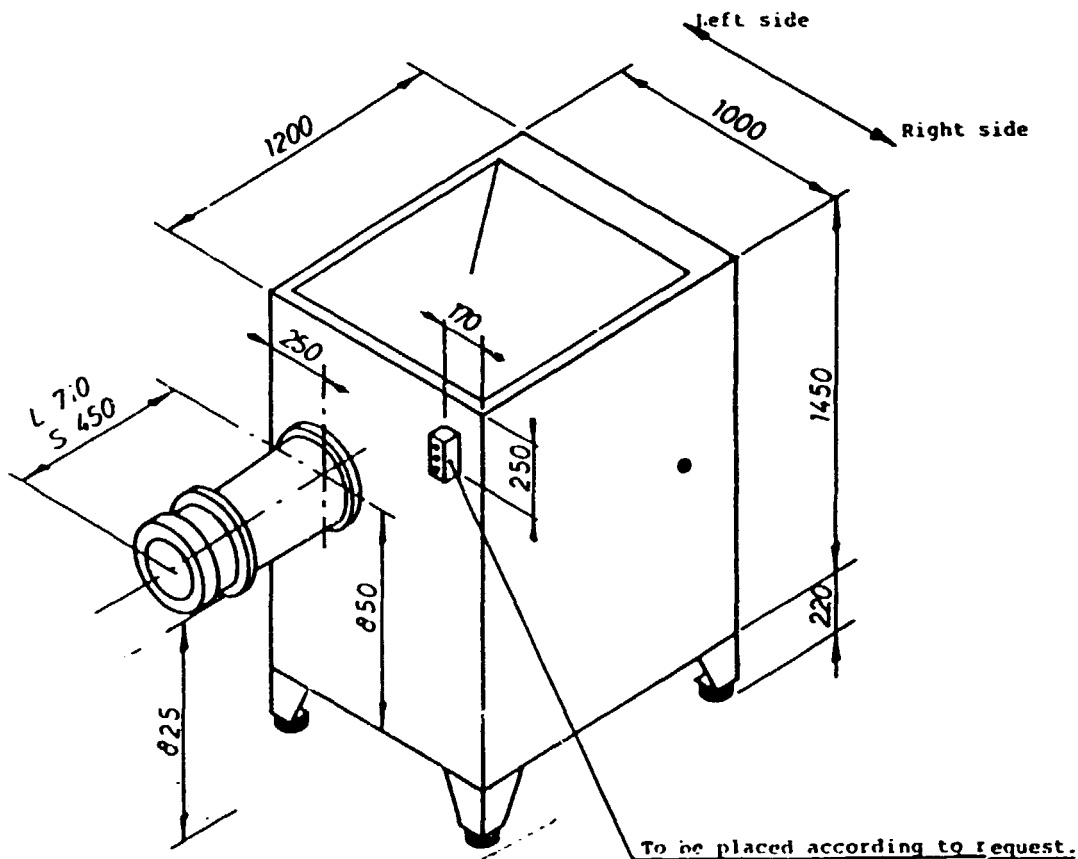
## Results from different samples during long-term trials

Test No.	1	2	3
<b>Fat from decanter:</b>			
Saponification value	191.4 mg KOH/g	190.4 mg KOH/g	175.8 mg KOH/g
Water and solids contents	0.45%	0.7%	0.19%
<b>Water from decanter:</b>			
Fat contents	0.28%	0.14%	0.09%
pH	12.0	1.67	11.7
COD	74.7 g/l	67.6 g/l	68.3 g/l
BOD <sub>5</sub>	30.0 g/l	93.2 g/l	27.4 g/l
KMnO <sub>4</sub> consumption	21.7 g/l	14.0 g/l	17.0 g/l
Solids content dissolved and undissolved	10.3%	8.5%	9.2%
<b>Solids from decanter:</b>			
Fat contents	4.3%	3.8%	6.4%
Solids (total)	38.2%	30.75%	46.3%
<b>Heavy metals (AAS) in fat from decanter:</b>			
Lead	not detectable (smaller 0.02 mg/kg)		
Cadmium	not detectable (smaller 0.002 mg/kg)		
Mercury	not detectable (smaller 0.020 mg/kg)		

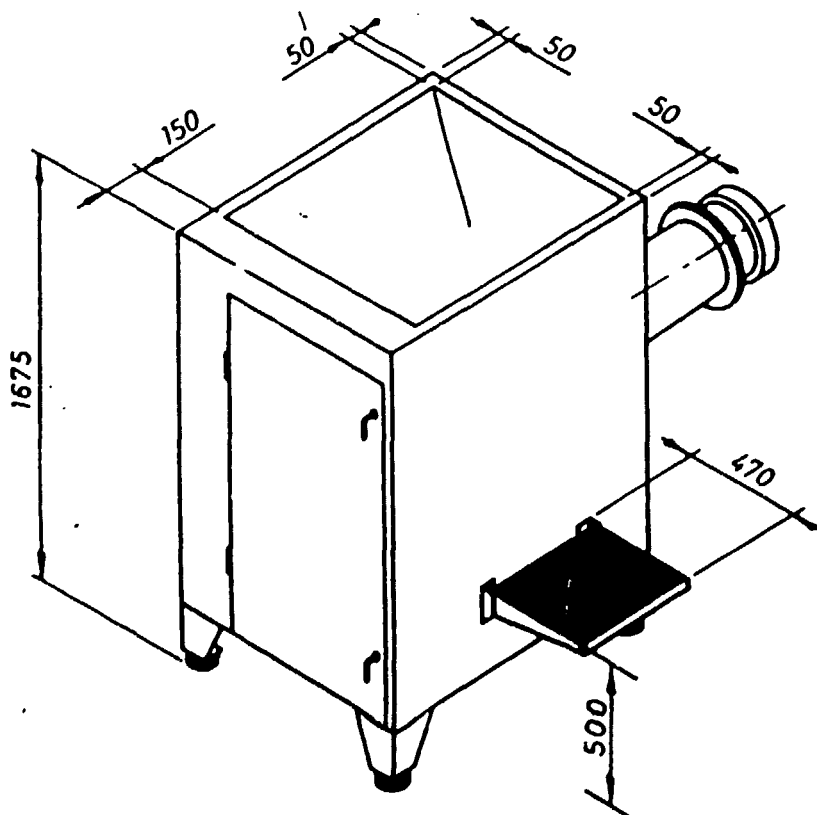


**WOLFKING**  
DANMARK A/S  
DK 4200 Slagelse · Denmark

ANNEX 4:  
DIMENSIONS WOLFKING UNIVERSAL WOLF GRINDER



To be placed according to request.



Q.NO.: \_\_\_\_\_ CUSTOMER: \_\_\_\_\_ Sign. \_\_\_\_\_ Date \_\_\_\_\_



# INFORMATION

## MELTING/COOKING PIPE

Steam consumption is approx. 120 kg per 1000 kg raw material to be cooked or melted, this corresponds with the heating energy of 8 litres fuel oil.

As good as noiseless if the steam does not contain water which will cause "pockets" in the pipeline.

The melting pipe is available for direct or indirect heating. When operating on direct steam injection the material will increase with some 10%. In other words, less water has to be added later in the process.

In order to achieve maximum capacity with a minimum of condense water it is imperative that the pipeline is completely insulated and a water trap is installed near the melting/cooking pipe.

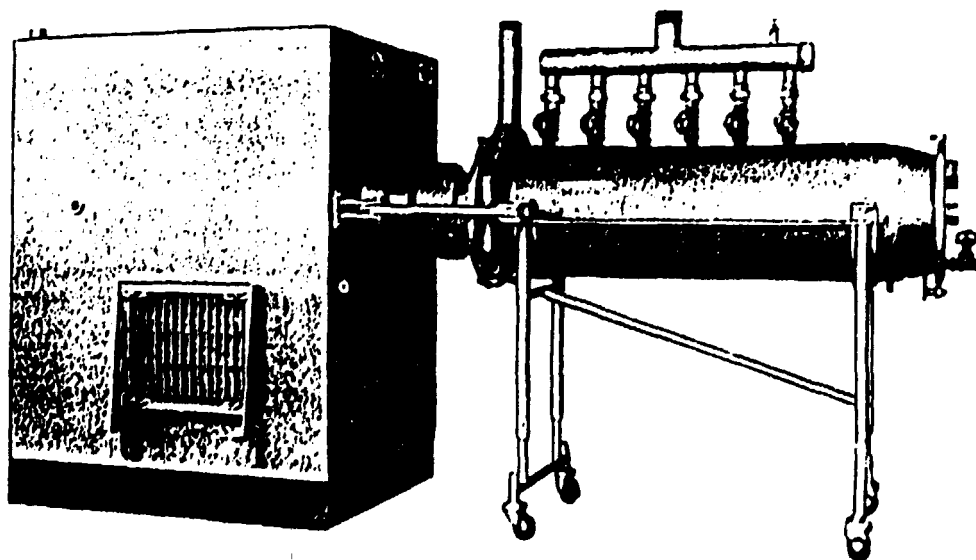
The equipment is furnished with double vacuum valves eliminating the risk of raw material entering the pipeline when supply of steam is halted.

Feeding of the combination grinder/melting pipe must be co-ordinated with the supply of steam.

Max. temperature: 95° C.

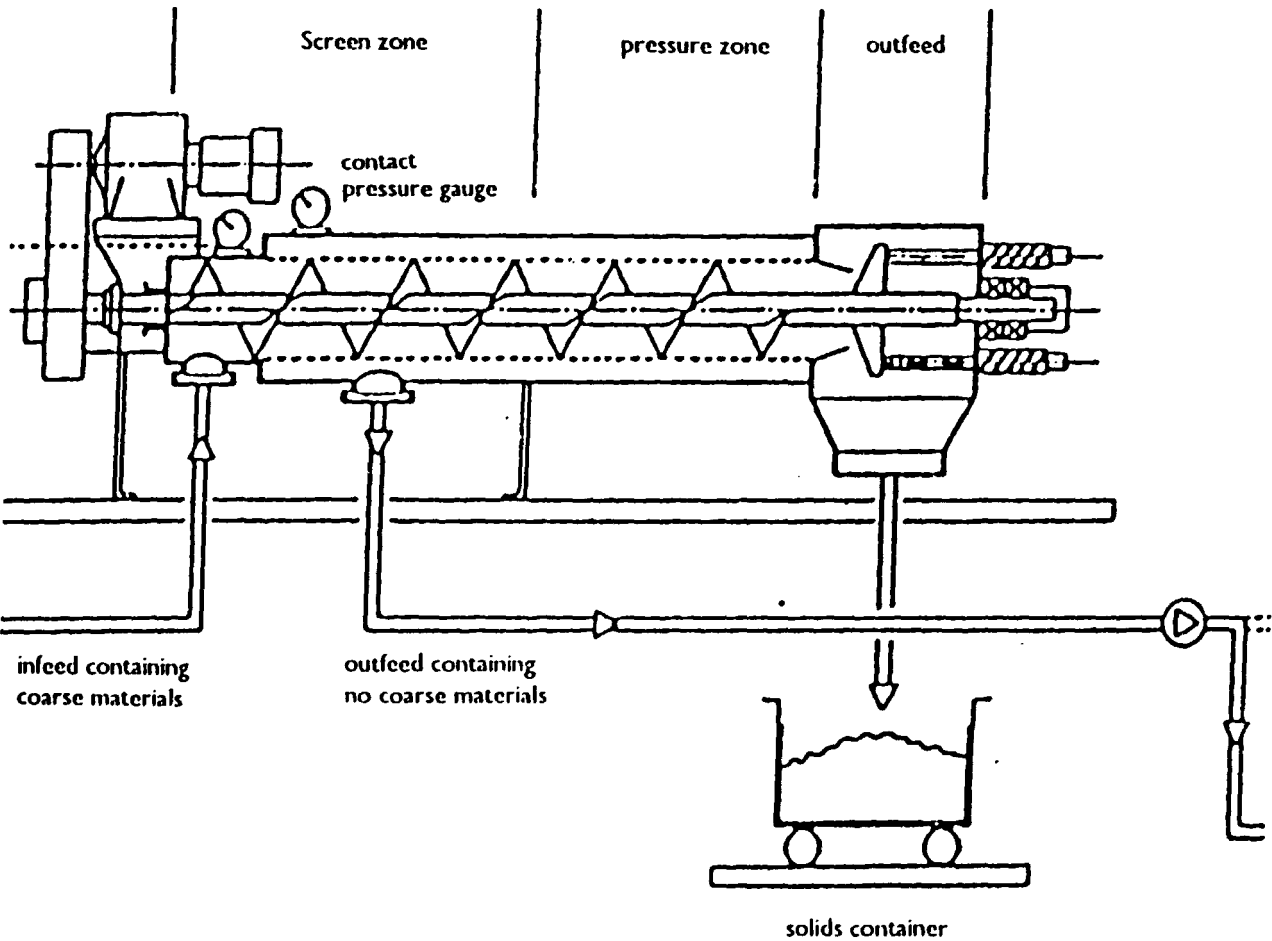
The cooking/melting pipe can be used when cooking meats, liver, lungs, kidneys as well as bony materials.

250 mm Melting/Cooking Pipe

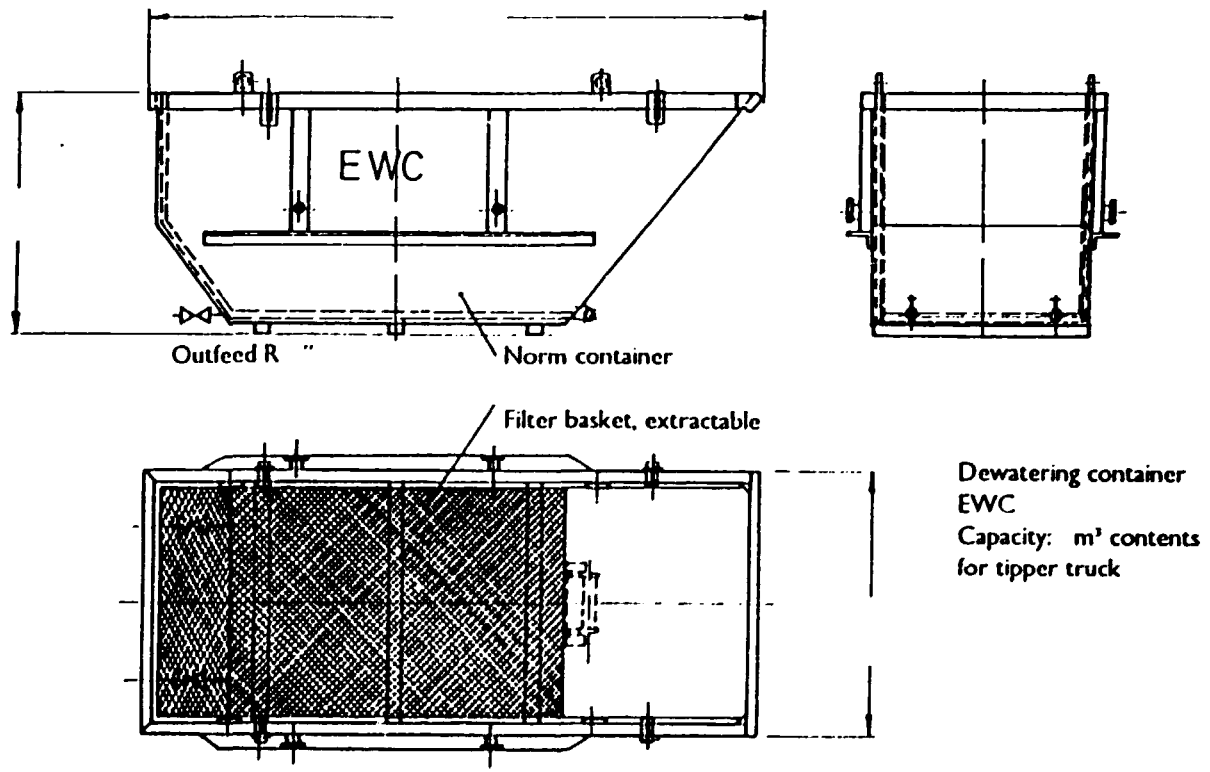




ANNEX 6:  
DEWATERING PRESS



ANNEX 7:  
DEWATERING CONTAINER



Type of determination	Sample 1	Sample 2	Sample 3	Sample 4
Water	5.0 %	5.7 %	6.7 %	10.3 %
Dry matter (TS)	95.0 %	94.3 %	93.3 %	89.7 %
Fat	12.5 % on TS	12.3 % on TS	12.3 % on TS	13.2 % on TS
Ash	16.4 % "	15.9 % "	17.4 % "	14.9 % "
Sulphide	0.01 % "	0.01 % "	0.01 % "	0.008 % "
Raw protein	60.0 % "	64.1 % "	61.4 % "	64.3 % "
Digestible protein	56.4 % "	61.1 % "	58.9 % "	60.5 % "
Digestibility	94.0 %	95.2 %	95.8 %	94.1 %
pH	12.6 %	12.6 %	12.6 %	12.5 %

ANNEX 8:

Analyses of protein meal from lime waste on the basis of South German hides

ANNEX 9:

Characteristics of fat from lime waste on the basis of South German hides

98.5 - 99 % Pure Fat

< 1 % Water

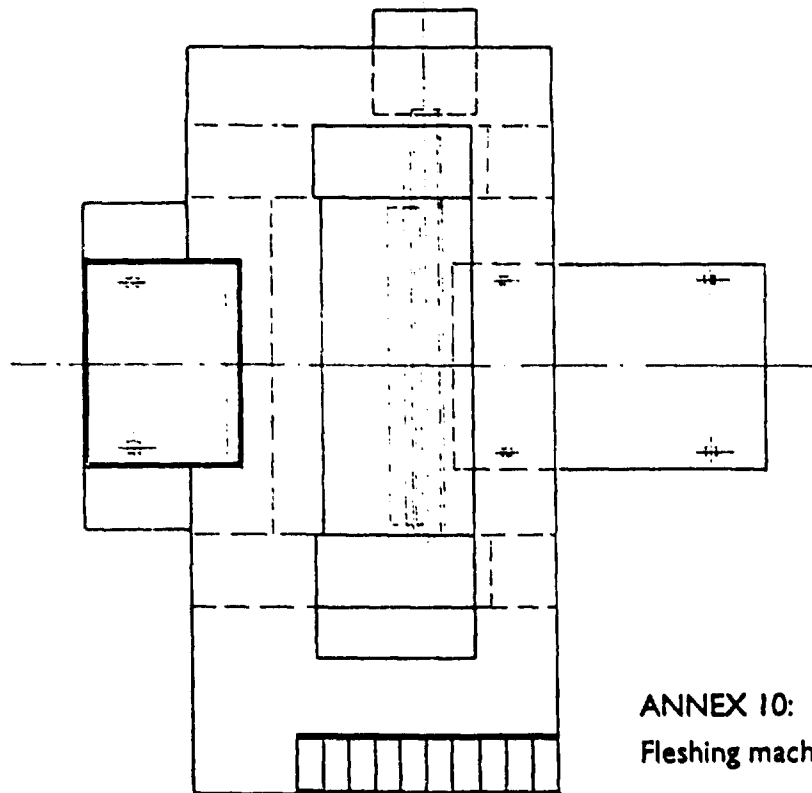
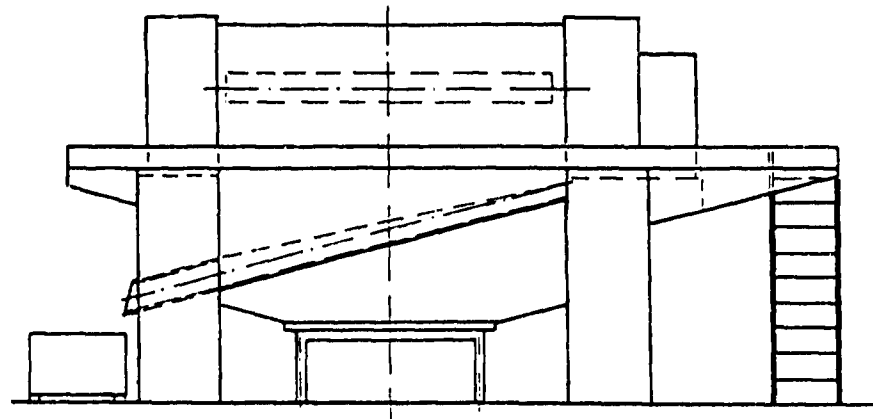
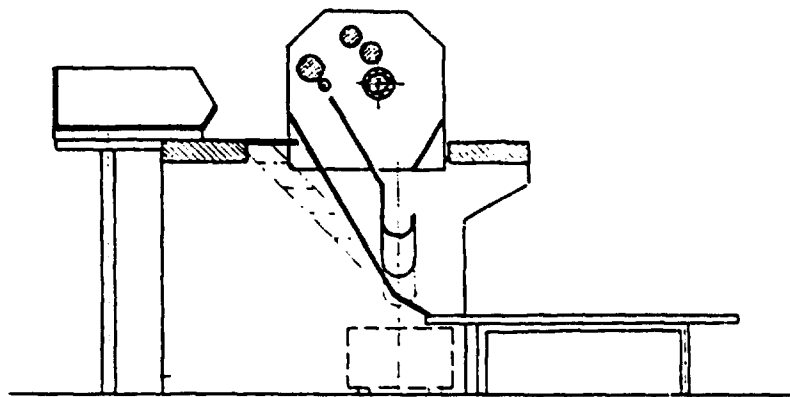
< 0,5 % Ash and other  
impurities

Acid value 0 - 1

Saponification  
value 190 - 200

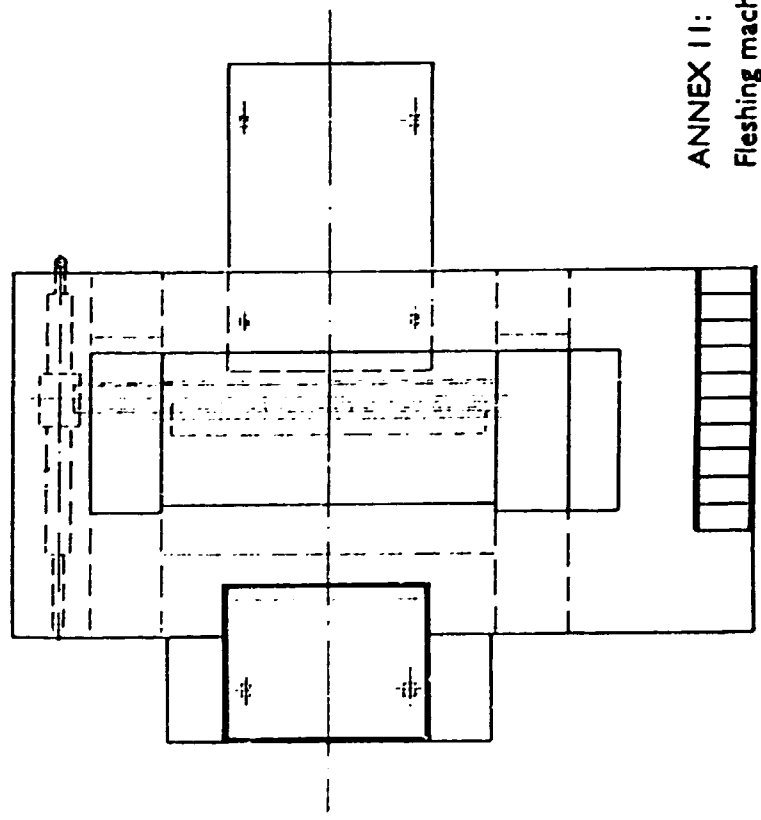
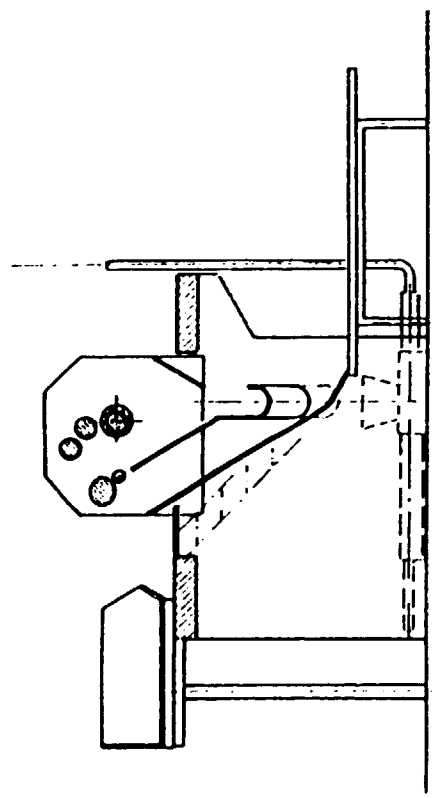
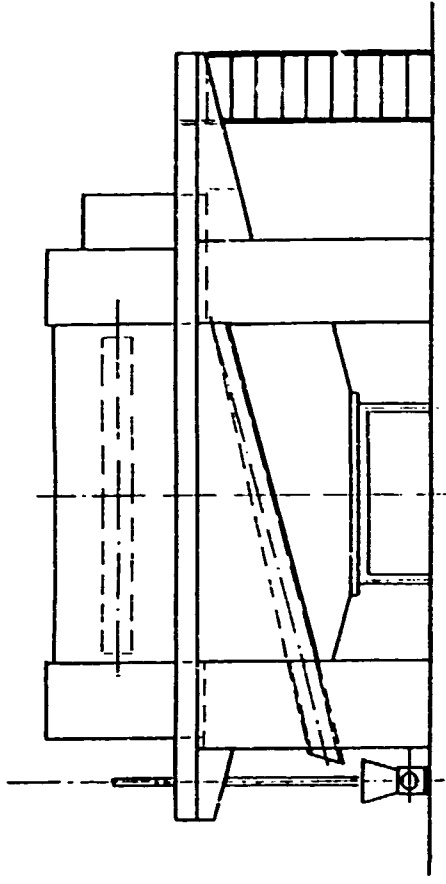
Iodine value 54 - 59

Melting point at 40 °C



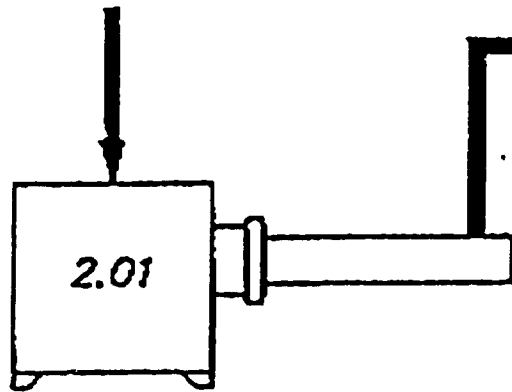
ANNEX 10:

Fleshings machine on a platform, fleshings are fed into a dewatering container by gravity



ANNEX 11:  
Fleshing machine on a platform, fleshings are fed into a fleshing pump by gravity

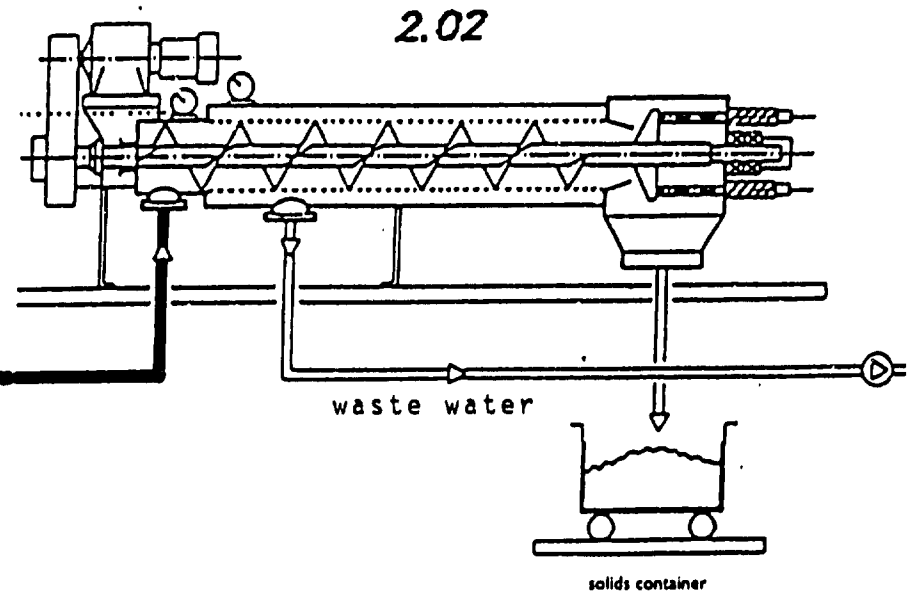
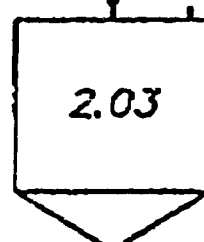
RAW  
MATERIAL



ANNEX 12:

Schematic diagram of processing green waste

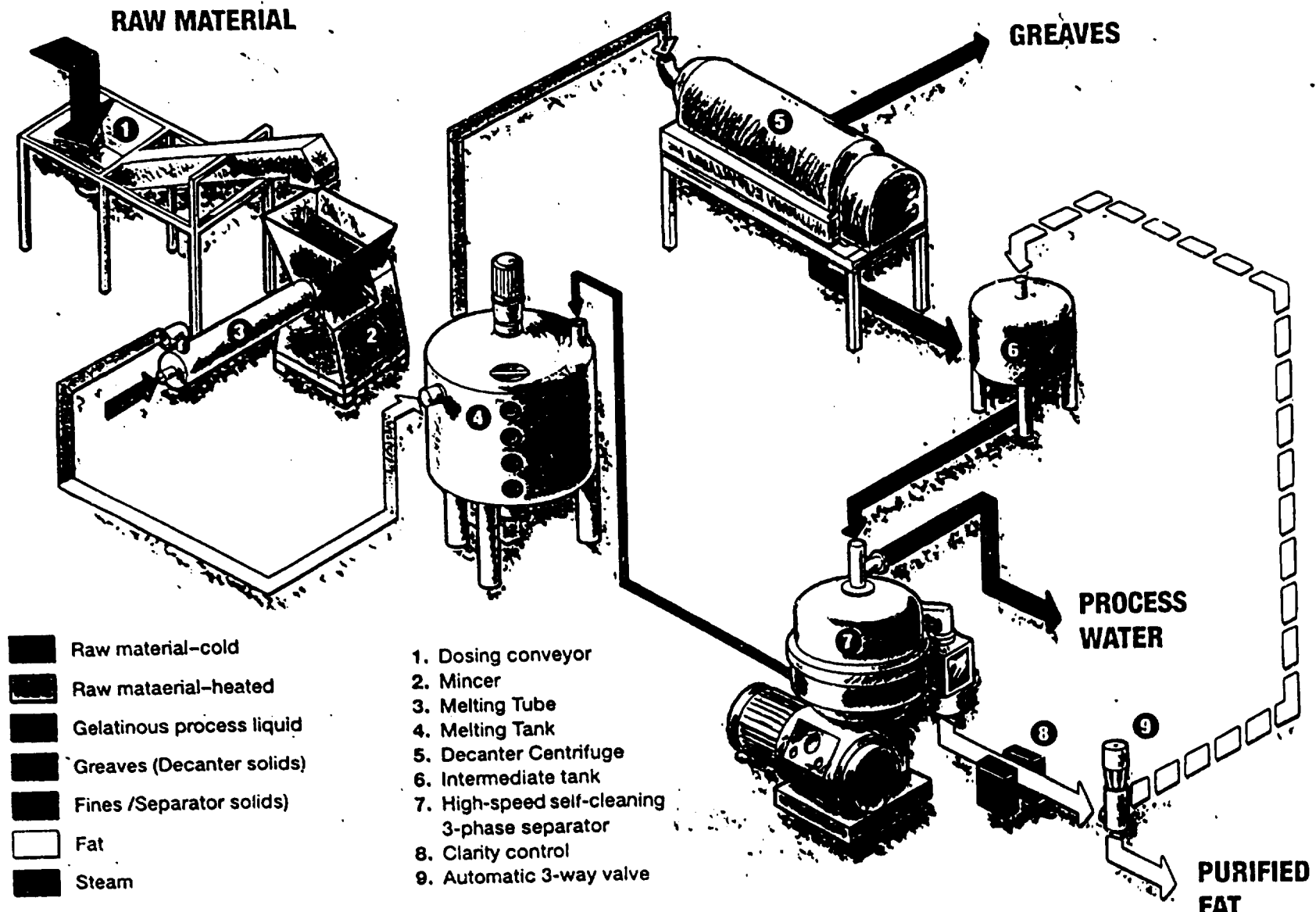
- 2.01 RAW MATERIAL MINCER
- 2.02 DEWATERING PRESS
- 2.03 INTERMEDIATE TANK
- 2.04 FEED PUMP



ANNEX 13:

Schematic diagram of the Alfa Laval plant

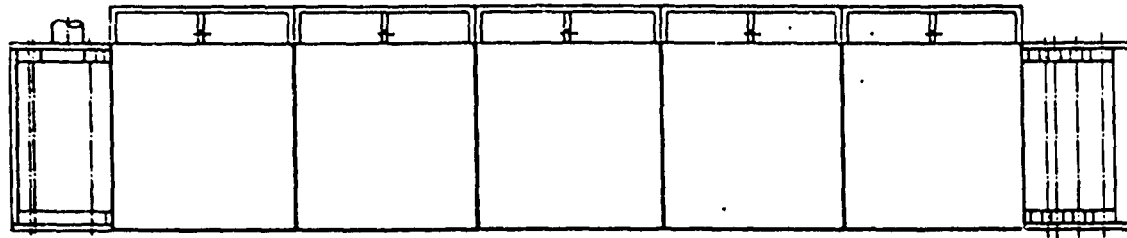
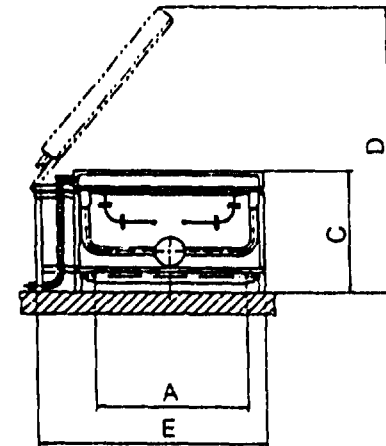
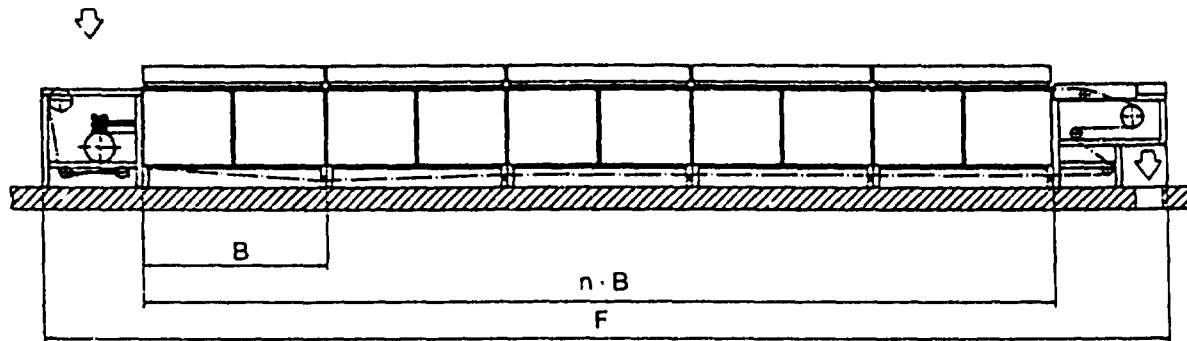
A CONTINUOUS WET RENDERING PROCESS FOR PROCESSING SOFT FATTY TISSUES





ANNEX 14:

Dryer for greaves (solids) coming from decanter



	A	B	C	D	E	F
	Belt width	Chamber length	Chamber height	Chamber height Lid open	Dryer width	Dryer length
Dryer type	mm	mm	mm	mm	mm	mm
KBT 10	1000	2400	1650	2700	1800	2250 + (2400 · n)
KBT 15	1500	2400	1650	3100	2400	2450 + (2400 · n)
KBT 20	2000	2400	1650	3500	3000	2700 + (2400 · n)

n = Number of chambers

ANNEX 15:

**Round-up meeting in Kenya**

Agenda for round-up meeting on the utilisation of tannery lime waste on 24 September 1993 between Consultant Mr. H. Zäpfel, German Tanning College, Reutlingen and Mr. A. Zink, UNIDO Tanning Machines Export, Nairobi.

- 7.1. Definition of waste and by-products.
- 7.2. Summary of factory visits made during the consultant's mission.
- 7.3. Practical experience gained in EUROPE; constraints, limitations in respect of technology and cost factor
  - fleshing after liming
  - fleshing before liming.
- 7.4. Possible technologies applicable in case of Kenya in view of the volume of lime waste generation and other additional sources.
- 7.5. Indicative cost comparisons on different processes employed pending on final products manufactured (fat, protein).
- 7.6. Any other matters:
  - How to increase the value-added in Kenya tanneries.

The following people were present at this meeting:

As UNIDO PANEL:

Mr. GERHARD FELSNER	UNIDO CTA of US/RAF/92/200
Mr. HORST ZAEPFEL	CONSULTANT working with the GERMAN TANNING COLLEGE, REUTLINGEN
Mr. J.M. MURIUKI	REGIONAL COORDINATOR
Dr. SAM KIRUTHU	UNIDO CONSULTANT US/RAF/ 92/200
Mr. NGHIA QUANG LE	UNIDO ASSOCIATE EXPERT
Mr. AUGUSTO ZINK	UNIDO TANNING MACHINERY EXPERT

TANNERS PANEL:

Mr. J.G. KAHIU	BULLEYS TANNERIES LTD. MANAGING DIRECTOR
Mr. R.C. KINYA	BULLEYS TANNERIES LTD. PROD. MANAGER
Mr. J.J. DASS	BABAZIR TANNERY LTD. LEATHER TECH.
Mr. J.M. GIGANTE	BATA/LIMURU TANNERY MANAGER
MR. A. KASSAM	LEATHER INDUSTRY OF KENYA MANAGER
MR. D. MANICHAMSAGAM	BLUTAN LTD.
MRS. S. HINSON	BLUTAN LTD.

LOCAL AUTHORITIES

Mr. F.N. KIHUMBA	NES
Mr. P. WERU	WATER DEVELOPMENT (absent w. apologies)