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CERTIFICATION COURSES

Dairy and Food Process and Products Technology

PROF. TRIDIB KUMAR GOSWAMI
AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT
IIT KHARAGPUR

Lecture 51: Cheese

History of Cheese making

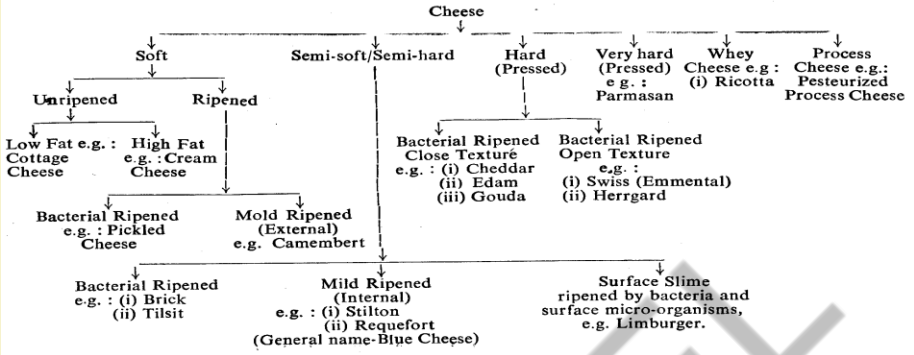
No one knows who first made cheese, but the most popular story is that an Arab put milk into a bag made from a sheep's stomach to take with him on a trip.

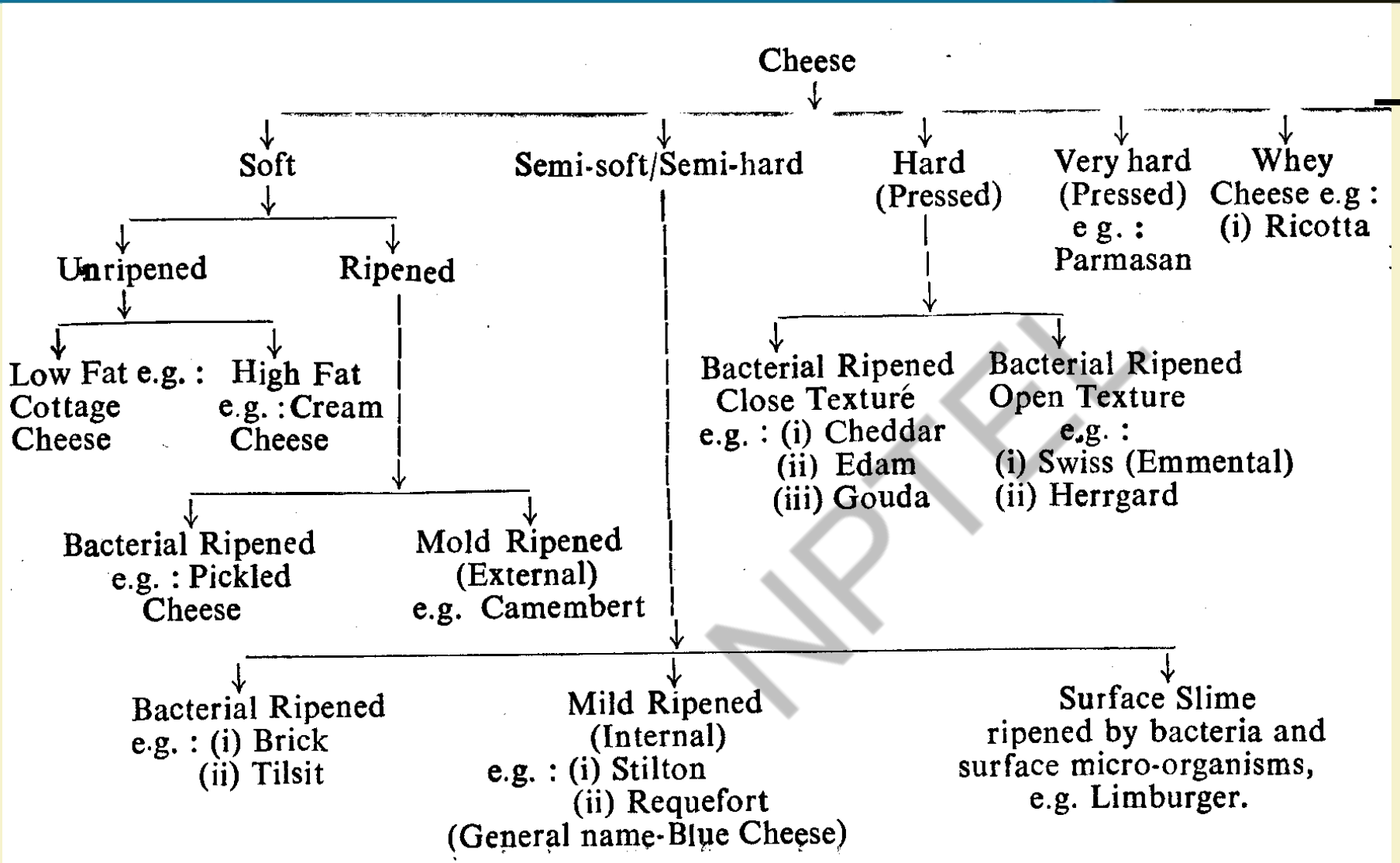
By the time he was ready for a drink, the rennet from the sheep's stomach, along with the warmth and gentle agitation had turned his milk into a type of cheese.

CHEESE

Definition:

Cheese is the curd or substance formed by the coagulation of the milk of certain mammals by rennet or similar enzymes in the presence of lactic acid produced by added or adventitious micro-organisms, from which part of the moisture has been removed by cutting, warming and / or pressing, which has been shaped in a mould and then ripened by holding for some time at suitable temperature and humidities.


Cheese
Soft
Semi-soft/Semi-hard
Hard (Pressed)
Very hard (Pressed) e.g. : Parmasan
Whey Cheese e.g : (i) Ricotta
Process Cheese e.g.: Pesteurized Process Cheese
Unripened
Ripened
Low Fat e.g. : Cottage Cheese
High Fat e.g. : Cream Cheese
Bacterial Ripened Close Texture e.g. : (i) Cheddar (ii) Edam (iii) Gouda
Bacterial Ripened Open Texture e.g. : (i) Swiss (Emmental) (ii) Herrgard
Bacterial Ripened e.g. : Pickled Cheese
Mold Ripened (External) e.g. Camembert
Bacterial Ripened e.g. : (i) Brick (ii) Tilsit
Mild Ripened (Internal) e.g. : (i) Stilton (ii) Requefort (General name-Blue Cheese)
Surface Slime ripened by bacteria and surface micro-organisms, e.g. Limburger.



Process cheese e.g.,: Pasteurized process cheese

COMPOSITION:

Name	Moisture	Fat	Protein	Ash and Salt
Brick	42.5	30.7	21.1	3.0
Camembert	47.9	26.3	22.2	4.1
Chedder	36.8	33.8	23.7	5.6
Cottage	69.8	1.0	23.3	1.9
Cream	42.7	39.9	14.5	1.9
Edam	38.1	22.7	30.9	6.2
Gorgonzola	37.3	34.7	25.2	3.8
Limburger	54.8	19.6	21.3	5.2
Gruyere	30.0	28.2	33.0	4.0
Neufechatel	52.1	23.5	19.3	5.0
Parmesan	17.0	22.7	49.4	7.6
Romano	29.6	27.7	31.2	8.7
Roquefort	38.7	32.2	21.4	6.1
Sapsago	47.6	2.0	41.6	11.9
Swiss	**33.0**	**30.5**	**30.4**	**4.2**
Stilton	**33.6**	**31.2**	**29.0**	**3.0**

Two - Soft and hard varieties

Soft Varieties : (A) Low fat unripened cheese, (B) Cottage cheese

Cottage cheese - usually made from skim milk. Also may be made from reconstituted, concentrated skim milk or non fat dry milk.

When cheese contains not less than 4% fat - called creamed cottage cheese.

Two commercial methods - I) coagulation by acidity developed by the action of lactic starter. II) coagulation by the combined actions of lactic starter and a small quantity of rennet.

Process:

1) Pasteurize high quality of skim milk at 62 to 63 ^{o}C for 30 min or 72 ^{o}C for 15 secs.

2) Carefully adjust the milk temperature to 30 to 32 ^{o}C in case of short setting and 22 ^{o}C in case of long setting method.

3) Add 4-5% (in short-setting) or 0.3 to 1% (in long-settings) or fresh active starter. A mixed lactic starter lactic Streptococci and the associated Leuconostoc species are used.

4) Add rennet (in case of lactic acid and rennet cheese) at the rate of 1 ml for each 450 kg of milk, diluted 40 times its volume in pure water.

1 5) Cover the vat, preferably with a metal cover and leave it undisturbed until the milk has coagulated.

6) Cut the curd at a whey acidity of 0.5 to .55%. This may be about 4.5 to 5 hours (short setting) or 12 to 14 hours (long setting) after the starter was added. Curd knives used are usually 1/4 or 3/8 of an inch in size.

7) Fifteen mins. After cutting the curd, the temperature is gradually raised up to 43 to 52 ^{o}C. It will generally require from 45 min to 1 and 1/2 hours (short setting) or 2 to 2 and 1/2 hours (long setting) to reach this temperature. The temperature of whey is increased at the rate of

2.5 - 4 ^{o}C; during 15 minutes interval until the desired cooking temperature has been reached. Stirring operation should be done with utmost care.

8) When the curd particles have reached the desired firmness, drain the whey until the top of the curd begins to show.

9) The curd is washed 2 to 3 times - 1st washing with cold water at 21 ^{o}C (slow stirring for 10 mins), 2nd washing with water at 10 to 12 ^{o}C (10 - 15 min stirring), 3rd washing with water at 4.5 ^{o}C (usually not done).

10) After the last wash, water has been removed, the vat of curd is covered and allowed to drain thoroughly.

2) 11) The curd may or may not be slated.

12) Salting is done in two applications using not more than 1% of the salt of the weight of curd.

4) 13) The salted or unsalted curd is held at 1.5 ^{o}C.

5) 14) The cottage cheese may be creamed if so desired by using 14% fat cream so that content is not less than 4%.

Cheddar cheese: Closed texture bacterial ripened cheese

Cheddar is hard, close texture, bacterial ripened cheese, made from cow's milk. Raw or pasteurized milk may be used. Cheddaring is the name given to a step in making the cheese which includes - packaging, turning, piling or repiling the curd.

Method:

- Pasteurize high quality atandardized milk (casein / fat rato adjusted to 0.7 ± 0.01).
- Milk is taken in the cheese vat and temperature carefully adjusted to 30 ^{o}C.

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Lecture No. 52 : Chedder Cheese

Cheddar cheese: Closed texture bacterial ripened cheese

Cheddar is hard, close texture, bacterial ripened cheese, made from cow's milk. Raw or pasteurized milk may be used. Cheddaring is the name given to a step in making the cheese which includes - packaging, turning, piling or repiling the curd.

Method:

- Pasteurize high quality atandardized milk (casein / fat rato adjusted to 0.7 ± 0.01).
- Milk is taken in the cheese vat and temperature carefully adjusted to 30 ^{o}C.

- Inoculate with fine active lactic starter at the rate of 0.5 to 1.0 %, usually 0.7% after straining and stir thoroughly.
- Test for acidity, should not be 0.005 to 0.01% higher than original.
- Generally 0.25 to .4 % rennet is added diluted to 20 time of its volume with cold water. It makes possible to distribute the rennet thoroughly and uniformly. Milk is stirred thoroughly for 3 to 5 min after rennet is added and agitators are taken out leaving a cover on the vat to keep the surface warm and clean. Curd is set.

- The curd is ready to cut after 25 to 30 min of addition of rennet. It will give a clean split when the thermometer or any such thing is inserted at a 45 degree angle and then lifted straight out.

- The whey immediately after cutting, contains 0.05 to 0.08 % less titrable acidity than the milk at the time of renneting. This is because the curd contains practically all the casein and a portion of the phosphates. Free whey quickly appears between the cut cubes of curd and the curd tends to sink slowly. Agitation starts but should not be vigorous such that curd is broken. Matting should be avoided.

Heating or cooking begins within 15 minutes after cutting. Enough free whey should be there in the vat to float the curd. It helps to keep curd away from direct contact with the vat. Cooking should be started slowly so that 38.8 ^{o}C will reach in 30 mins as:

Min after turning on steam	Temp. of curd & whey
0	31 ^{o}C
5	31.6 ^{o}C
10	32.6 ^{o}C
15	33.8 ^{o}C
20	35.5 ^{o}C
25	37.2 ^{o}C
30	38.8 ^{o}C

After turning off steam continue stirring slowly for atotal period of 45 min. At this time the curd will begin to feel shotty firm and somewhat elastic when squeezed. Curd particles will be only about half as large as they were at cutting. Acidity will be approaching the desired limit (0.12 to 0.13 %). No soft centres of curd particles.

Stirring is stopped. Curd is allowed to settle to the bottom of the vat. Insert the strainer and start to draw the whey.

Cover up the vat to keep the curd warm and clean.

Cheddaring (packing, turning, piling and repiling) lasts for two hours.

Two objectives a) to control the moisture b) to form the characteristic body and texture. Packing: interval between dipping and packing is not less than 5 min and not longer than 15 min. Thickness of the curd slab reduces by 1 or 2 inches. Cut the blocks in 6" thick, 6 - 8" wide, and 20" long. Roll bottom side up in the vat.

Turning: Turn at intervals of 15 min. and repeat at every 15 min interval till the curd is ready for milling and salting. Keep vat covered to maintain temperature after every turning and to prevent air borne contamination. For best result curd is kept above 32.2^{o}C.

Piling the block Two high: In 30-45 min after packing, the blocks are turned piled two high. Temperature is 2-3 degree less than at the time of dipping. At this time the blocks are about 24" long and 3 to 4 " thick. They can be cut to 12" long to handle them with ease. The blocks are turned after the usual 15 min interval and piled two high. Blocks from the top layer are placed in the bottom layer.

Piling the blocks three high: At 30 - 45 min after piling two high, blocks are turned again and piled in three layers. This is for control of moisture and very close texture if desired (occasionally more than three layers.

End of cheddaring: Lasts for approx. 2 hrs. Time period is extended if lower moisture and very close texture is desired. Whey draining from the curd should have 0.3 to 0.35% more acid than at the time of cutting ().1%). PH about 5.4. Body is plastic, smooth to the touch and can be torn apart in thin, meaty shreds or strips. The temp is approx. 32.2 ºC.

Milling the curd: 5/8" square and 2" long, milled using a mill. Stir it enough to prevent matting.

Salting the curd: The desired salt content is approx. 1.5% but may range between 1 - 2%.

Added in 3 - 4 parts uniformly over the curd and each time the curd is let to drain for 10 min so that salt is dissolved and curd is smooth feeling, firm and elastic.

Hooping, pressing and dressing: The temp. of the curd is between 30.5 to 31.5 ^{o}C. Press as soon as the hoops are filled. Press hard enough at first, to start the whey dripping from each hoop, increase the pressure gradually untill full pressure is applied in 15 min after starting. The curd is ready to dress not sooner than 15 min after full pressure has been applied.

Removing the cheese from hoop: Next morning take the cheese from the hoops. Weighed, marked with date, lot no. etc. The cheese is removed from the making room to the drying room where it is neatly arranged on clean shelves or tables. Temp. is maintained at 12.7 to 15.5 ^{o}C with a relative humidity of 50%. The cheese is turned at 24 hr interval so that both ends and sides can dry and form the desired rind. Each time during turning wipe off the surface of the shelves with a clean dry cloth. Cheese will show proper rind development in 3 - 4 days.

Paraffining: dipping cheese for a few seconds (3 to 5) into a bath of melted paraffin (temp 115 to 121 ºC) or a mixture of paraffin and wax to get a thin and somewhat flexible coating.

Curing:

Definition: The curing / ripening / souring / maturing of cheese refers to the storage of cheese for at least 2 to 3 months at a given low temperature (0 – 16 ^{o}C), during which its physical, chemical, and bacteriological properties are profoundly changed resulting in the development of a characteristic flavour, body, and texture.

The term GREEN CHEESE is usually applied to hard-pressed cheese in the early stages of ripening before the characteristic flavour, body and texture of ripened cheese have developed.

Ripening agents: mainly bacteria and moulds and enzymes including pepsin. System of curing

Particulars	Cold curing	Warm curing
Temperature	0 – 4 ^{o}C Avg. 1.5 ^{o}C	10 – 16 ^{o}C Average 12.5 ^{o}C
Humidity	75 %	85 %
Duration	3 to 12 mths	½ to 2 mths
Quality of cheese obtained	Mild flavour, bacterial defects minimized	Sharp flavour, bacterial defects exaggerated.

Changes during curing:

Flavour: From mildly acid taste and aroma (no real cheese flavour) in green cheese to the development of the characteristic flavour of ripened cheese, which is a blend of several odours and tastes, such as diacetyl in mild cheese, to traces of odours of butyric and cproic acid, esters of alcohol, salts of propionic and acetic acids in well aged cheese and pungent odours of compounds of ammonia and sometimes hydrogen sulfide in very old cheese.

Body: The cheese become slightly harder due to loss of moisture. There is also a gradual change from the rubbery body in green cheese to a mellow and waxy body in ripened cheese.

Texture: Fairly close to close texture.

Chemicals: fermentation of lactose to lactic acid, and small amount of acetic, propionic acids and carbon di-oxide; proteolysis and a slight fat break down. Proteins are broken down to more soluble fractions of about 25 %. Ammonia produced by certain moulds and bacteria may have considerable effect on pH.

pH of cheese (chedder) in relation to age

Age of cheese	PH
3 days	5.05
7 days	5.06
49 days	5.13
9 months	5.32
24 months	5.58

Microbiological changes

All cheese should contain predominantly lactic streptococci during manufacture and early stage of curing. Chedder cheese are low in moisture and close in texture sustain a steady change over from streptococci to lactobacilli, some of which contribute to the flavour. Other types are of course present and the higher the proportion of miscellaneous types, the quicker is the curing and greater the possibility of off-flavours.

Ripening index = (% soluble nitrogen / % total nitrogen) X 100

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Lecture No. 53 : Ice Cream

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Ice Cream : What it is Made of?

Milk Fat	:	10 – 12 %
MSNF	:	11 – 13 %
SUGAR	:	14 – 16 %
STABILIZERS	:	0.2 – 0.3 %
EMULSIFIERS	:	0.1 – 0.2 %
WATER & AIR	:	60–64% & 90-105% Respectively
FLAVOUR & COLOUR		

Ice Cream : What do the constituents do ?

(1)	MILK FAT	:	10 – 12 % (80 % FAT)
	Source	:	Cream, Butter
	Purpose	:	Improves Flavour, Produces Characteristic Smooth Texture
	Disadvantage	:	Retards Rate of Whipping, High in Calorie & Cholesterol
(2)	MSNF	:	11 – 13 % (Protein, Lactose & Minerals)
	Source	:	Milk Solids
	Purpose	:	Provides Food Value, Improves Palatability & Texture, Resists MELTING
	Disadvantage	:	Lowers FREEZING POINT, Causes SALTY taste & Sandiness

Ice Cream : What do the constituents do ?

(3)	SUGAR	:	14 – 16 %
	Source	:	SUCROSE
	Purpose	:	Makes Ice Cream Sweet, Improves Texture & Flavour
	Disadvantage	:	Lowers Whipping Ability, Increases Freezing Time Lowers HARDENING temperature
(4)	EMULSIFIERS	:	Maximum 0.2 %
	Source	:	Mono or Di Glycerides
	Purpose	:	Increases Whipping Quality, Gives Drier & Smoother Ice Cream, Distributes Air Cells Uniformly
	Disadvantage (If Excess)	:	Causes Slow Melting & Texture Defects

Ice Cream : What do the constituents do ?

(5)	STABILIZERS	: 0.2 – 0.3 %	
	Source	:	Sodium Alginate, Gelatin, Agar-Agar
	Purpose	:	Prevents COARSENING under Fluctuating Temperature
	Disadvantage (If Excess)	:	Causes Heavy & SOGGY Body, Resists Melting
(6)	Water & Air	:	60-64% and 90-105% respectively
	Purpose	:	Increase Volume
	Disadvantage	:	Increases Transport & Storage Cost
(7)	FLAVOUR	:	
	Source (Company's Secret)	:	Fruits & Nuts, Permitted Artificial Flavours
	Purpose	:	Increases Acceptability
	Disadvantage	:	Harsh Flavours, Reduce Acceptability Intense Flavour Satisfy Desire quickly

Ice Cream : What do the constituents do ?

(8) COLOUR : Company's Secret

Source : Permitted Food Colours

Purpose : Improves Acceptability
Aids in Identifying Flavour

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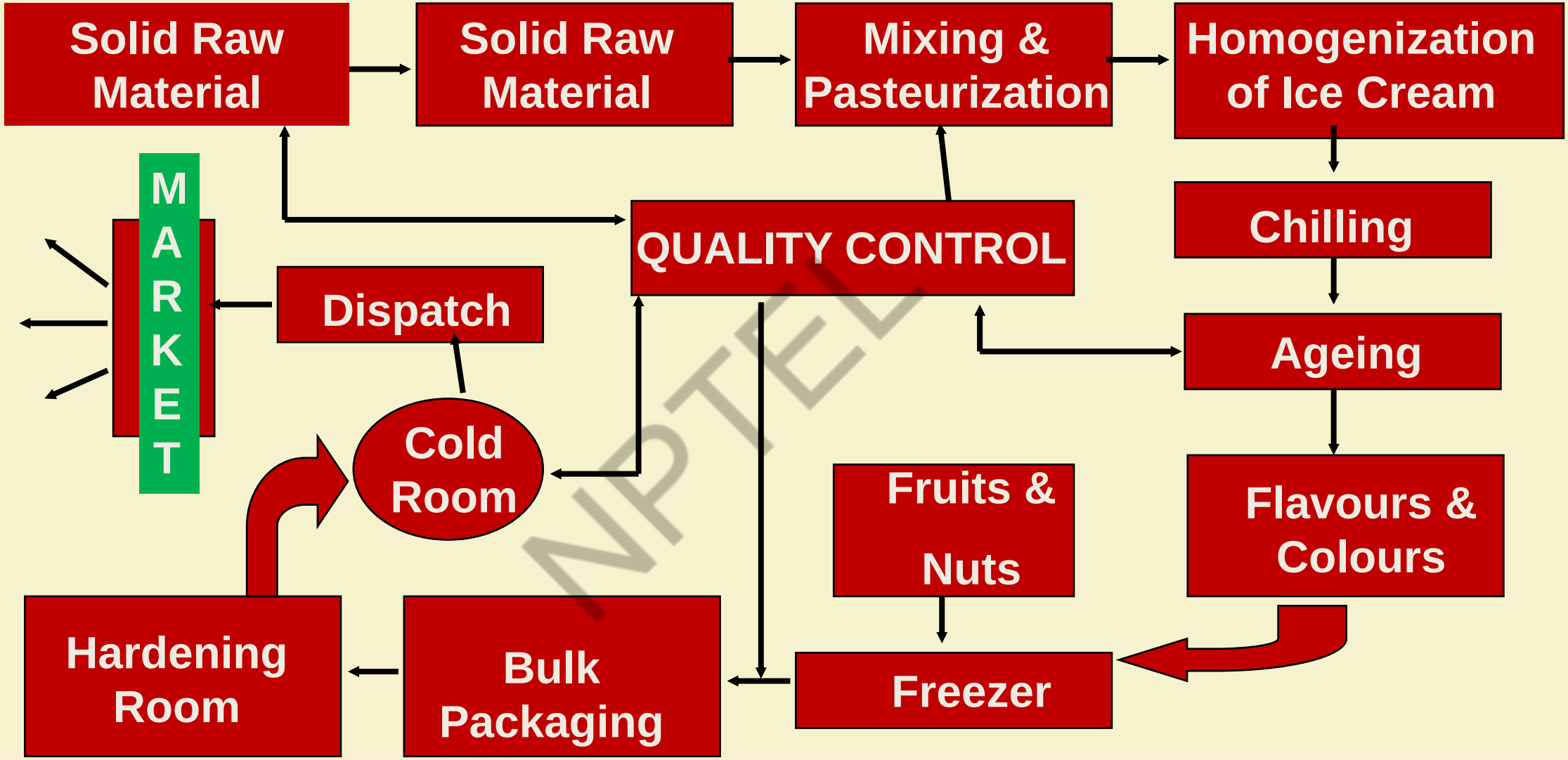
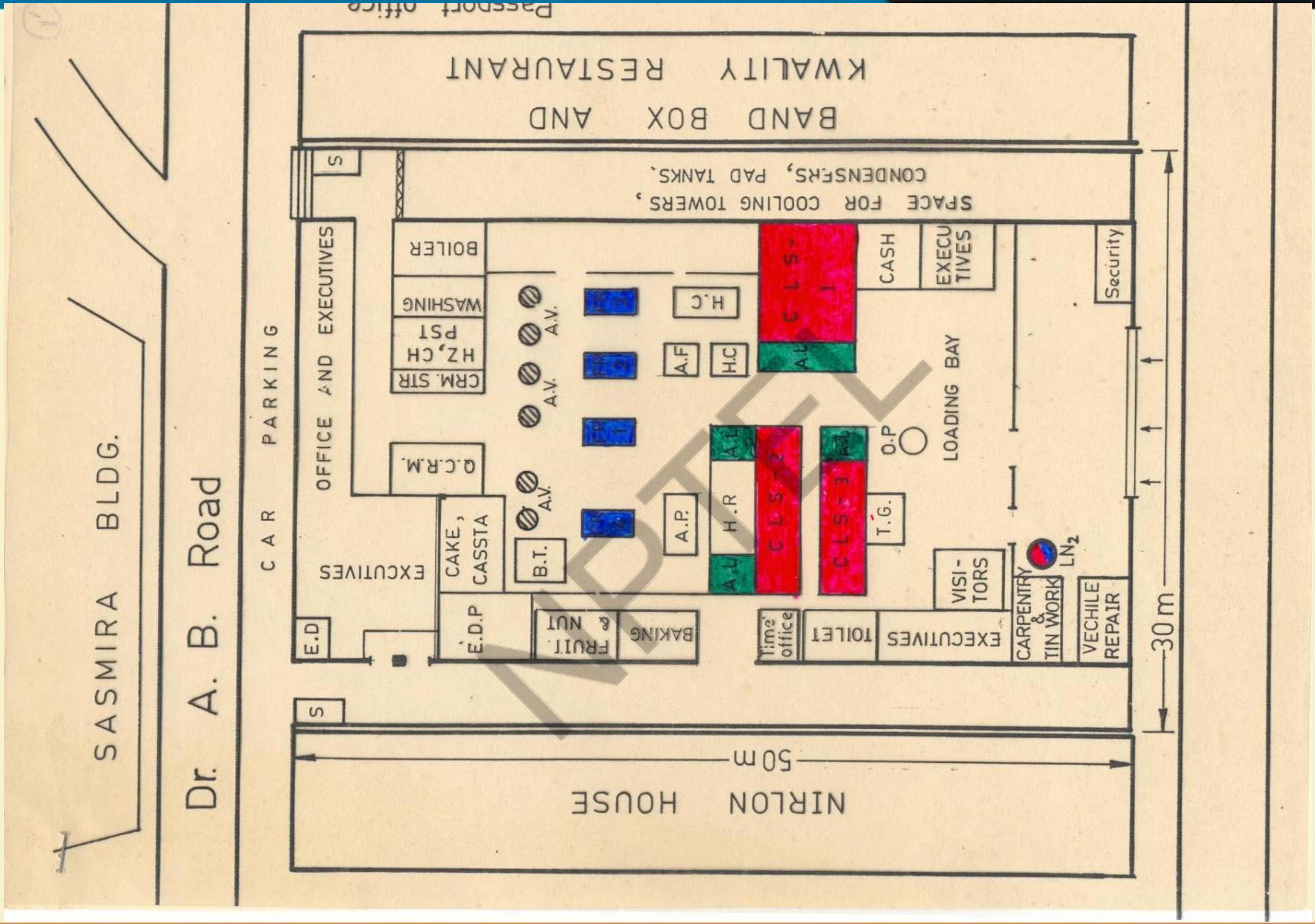
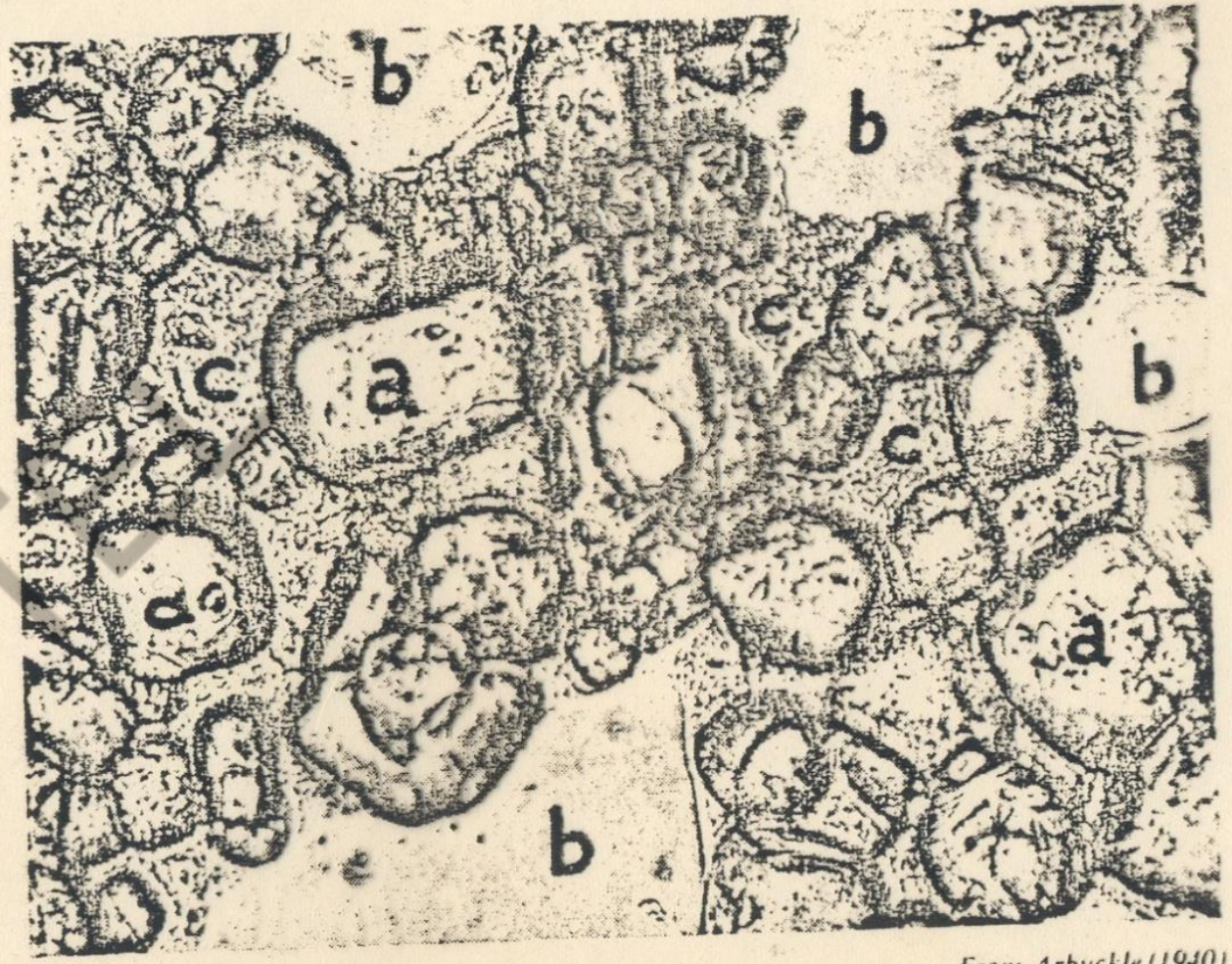
Lecture No. 54 : Process of Ice Cream Preparation


Solid Raw Material
Solid Raw Material
Mixing & Pasteurization
Homogenization of Ice Cream
Chilling
Ageing
Flavours & Colours
Fruits & Nuts
Freezer
Bulk Packaging
Hardening Room
Cold Room
Dispatch
MARKET
QUALITY CONTROL


Passport office
KWALITY RESTAURANT
BAND BOX AND
SPACE FOR COOLING TOWERS,
CONDENSERS, PAD TANKS.
S
BOILER
WASHING
PST
HZ,CH
CRM. STR
Q.C.R.M.
OFFICE AND EXECUTIVES
CAR PARKING
SASMIRA BLDG.
Dr. A. B. Road
EXCUTIVES
CAKE, CASSTA
B.T.
A.V.
A.V.
A.V.
H.C
A.F
H.C
C.L.S-1
A.L
A.L
C.L.S-2
A.L
H.R
A.P.
A.L
C.L.S-3
T.G.
O.P
LOADING BAY
CASH
EXECU TIVES
Security
VISI-TORS
LN2
E.D
E.D.P
FRUIT & NUT
BAKING
Time office
TOILET
EXECUTIVES
CARPENTRY & TIN WORK
VECHILE REPAIR
30 m
S
50 m
NIRLON HOUSE



From Arbuckle (1940)

FIG. 12.4. THE INTERNAL STRUCTURE OF ICE CREAM

(a) Ice crystals—average size, 45 to 55 microns. (b) Air cells—average size, 110 to 185 microns. (c) Unfrozen material—average distance between ice crystals or ice crystals and air cells, 6 to 8 microns. Average distance between air cells—100 to 150 microns.

ICE CREAM : How is it made?

	Process	Parameters
1.	Pasteurization	: 900 Ltr., Steam Jacketed Vessel 70 ^{0}C for 30 min.
2.	Homogenization	: 2000 L/h, 2 Stage (2500 psi & 500 psi) Fat Size 2 μ
3.	Chilling	: Counter Current Plate Heat Exchanger, Ethylene Glycol-Water Mixture, 2000 L/h at 4 ^{0}C
4.	Ageing	: Freon-12 Refrigerated Vat, 500 L, 4 hour
5.	Freezing	: 300-700 L/h, NH_3 Refrigeration, -5 ^{0}C
6.	Filling	: Manual/Automatic Packaging
7.	Hardening	: Hardening Room, NH_3 Duct, Air Temp. -40 ^{0}C , Predicted Temp. – 30 ^{0}C, 2-8 hr
8.	Cold Room	: Ammonia, - 25 ^{0}C
9.	Dispatch	: Insulated Shipper, Dry Ice Pad, Pad Van, Mechanically Refrigerated Van

Pasteurizer

Pasteurizer control panel

Homogenizer

Homogenizer

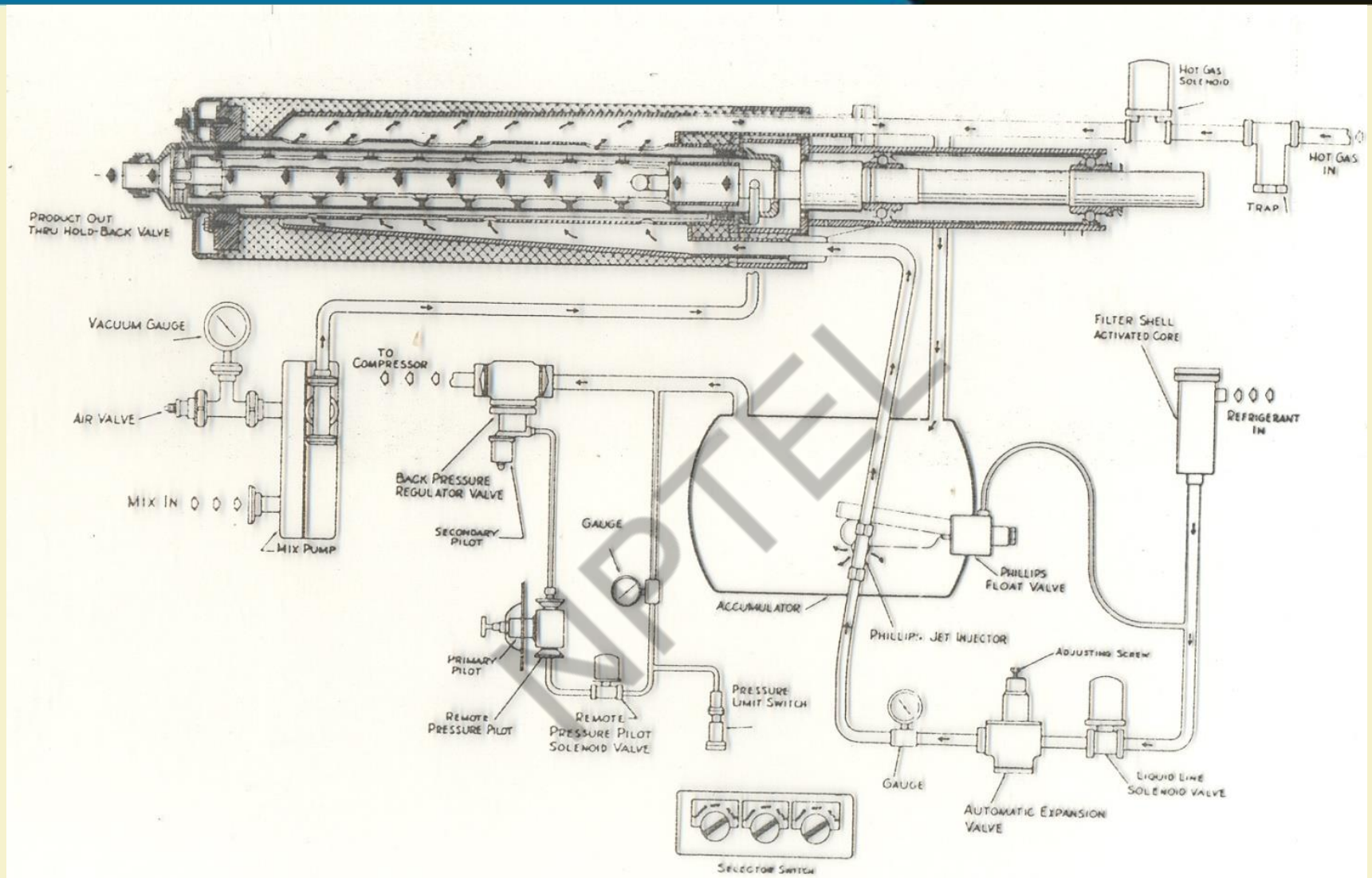


FIG. 1 DIAGRAM OF MODEL NO. 603 FREEZER

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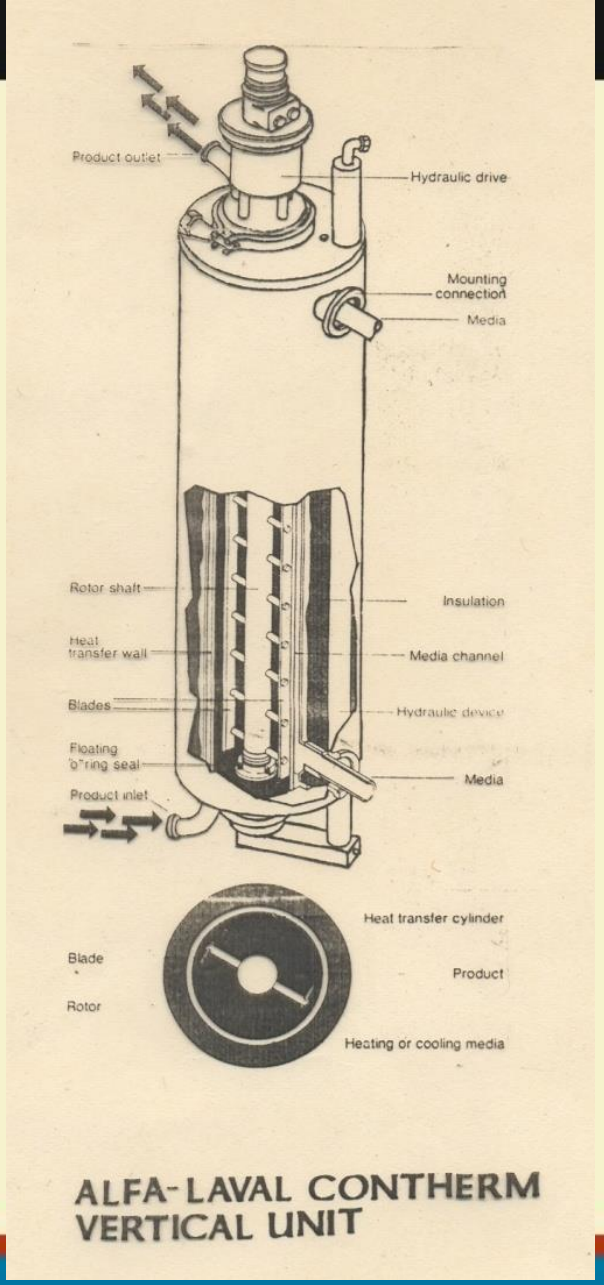
Lecture No. 55: Ice Cream Lolies



ALFA-LAVAL CONTHERM VERTICAL UNIT

Ice cream lolly stick machine

OVERRUN

BY VOLUME

$$\text{Overrun \%} = \frac{\text{volume of ice cream - volume of mix}}{\text{Volume of mix}} \times 100$$

e.g., ((9.5 - 5.0) / 5.0) X 100 = 90%

BY WEIGHT

$$\text{Overrun \%} = \frac{\text{Weight of I gal mix - weight of 1 gal ice cream}}{\text{Weight of 1 gal ice cream}} \times 100$$

e.g., ((8.85 - 5.06) / 5.06) X 100 = 74.9%

1 gal = 3.7854 Lit.

Example :

If 20 litre of fruit weighing 5 kg/litre is added to 100 litre of mix weighing 4.5 kg/litre, and 200 litre of ice cream is produced, what is the overrun in the mix?

Solution:

Ignoring fruit in the mix,

Overrun = (200-100)X100/100 = 100%

Considering fruit in the mix,

Overrun = (200-120)X100/120 = 66.6%

Then actual overrun is (200 - (100+20))X100/100 = 80%

Percentage of water frozen:

Temp ^{o}F									
25	*24*	*23*	*22*	*21*	*20*	*19*	*18*	*17*	*-15*
Water frozen %									
33	*41*	*47*	*52*	*56*	*59*	*62*	*64*	*67*	*90*

Refrigeration requirement during freezing:

Products sensible heat:

W = Wt. of Prd. X temp. range X sp. Ht.

Products latent heat:

W = Wt. of prd. X water frozen (%) X water in prd. X latent ht. of fusion of water

Thank You!!