Factors affecting Cracking of Soap

a) **The plodding process**: Historically the plodders were fitted with pressure plates between the worms and the cone. These are not recommended due to formation of "soap candles" which do not sufficiently blend together in the cone and therefore lead to cracking later on.

b) **Temperature during plodding**: Plasticity of the soap mass plays an important role and assists in bonding within the soap mass. An increase in temperature increases the plasticity and therefore bonding which reduces cracking in the soap. The downside of increasing temperature is that the adherence of the hot soap mass to the die increases therefore reducing stamper output as well as deteriorating tablet finish.

c) **Pressure in the plodder cone** : An increase in plodding pressure helps in the re-combination of the various mass of soap coming along a spiral of the worms. This has been historically tested and found that if the plodding pressure is above 10 bar then cracking is minimal. Twin worms and long extrusion barrel design was shown to give plodding pressures above this value.

d) **Liquid injected in the plodder cone** : Historically marbelisers have had dye injection into the plodder cones through specialised nozzles either on a distance piece or on a pressure plate. This dye injection brings in extra water which promotes planes of weakness leading to more cracking. Any unmixed water has been shown to give more cracking (either at plodder or mixer stage).

e) **Eyeplate design**: The best method of extruding soap is from a twin screw, double cone and single orifice eyeplate. Double orifice eyeplates have planes of weakness on adjacent faces of the billets and these when stamped later on contribute to cracking. Hence double orifice eyeplates are to be avoided. When they cannot be avoided to save on capital costs the cracking produced can be reduced if (a) minimum distance of 25 mm between the two orifices is maintained (b) the billet is turned through 90^{o}. This helps in 'stamping out" the extrusion lines of the billets centre.

f) **Shape of Billet** : A square shaped billet and a capacity type soap die can improve the orientation of the planes of weakness by promoting lateral flow of soap during the stamping operation. The converse is true for the shell and box die in conjunction with a rectangular cross section billet, in which there is minimal lateral flow.

g) **Shape of the stamped soap** : influences cracking. Selecting an optimised cushion shaped soap tablet can reduce cracking. The planes of weakness are reduced by lateral flow during stamping and terminate in a narrow area along the edge of the tablet and cracking is reduced. The converse is true for a landed brick shape tablet. The shell and box die does not promote soap flow during stamping and the planes of weakness terminate in a larger edge area.

h) **Starts & Stops**: When the plodder and mills are started after stopping especially glycerine soaps the soap intermeshed between the worms has already become cold/hard and then does not bind within the cone. Hence the higher the starts and stops the higher cracking will be experienced.

i) **Electrolyte concentration:** increase in electrolyte increases cracking. This occurs because of salting out effect

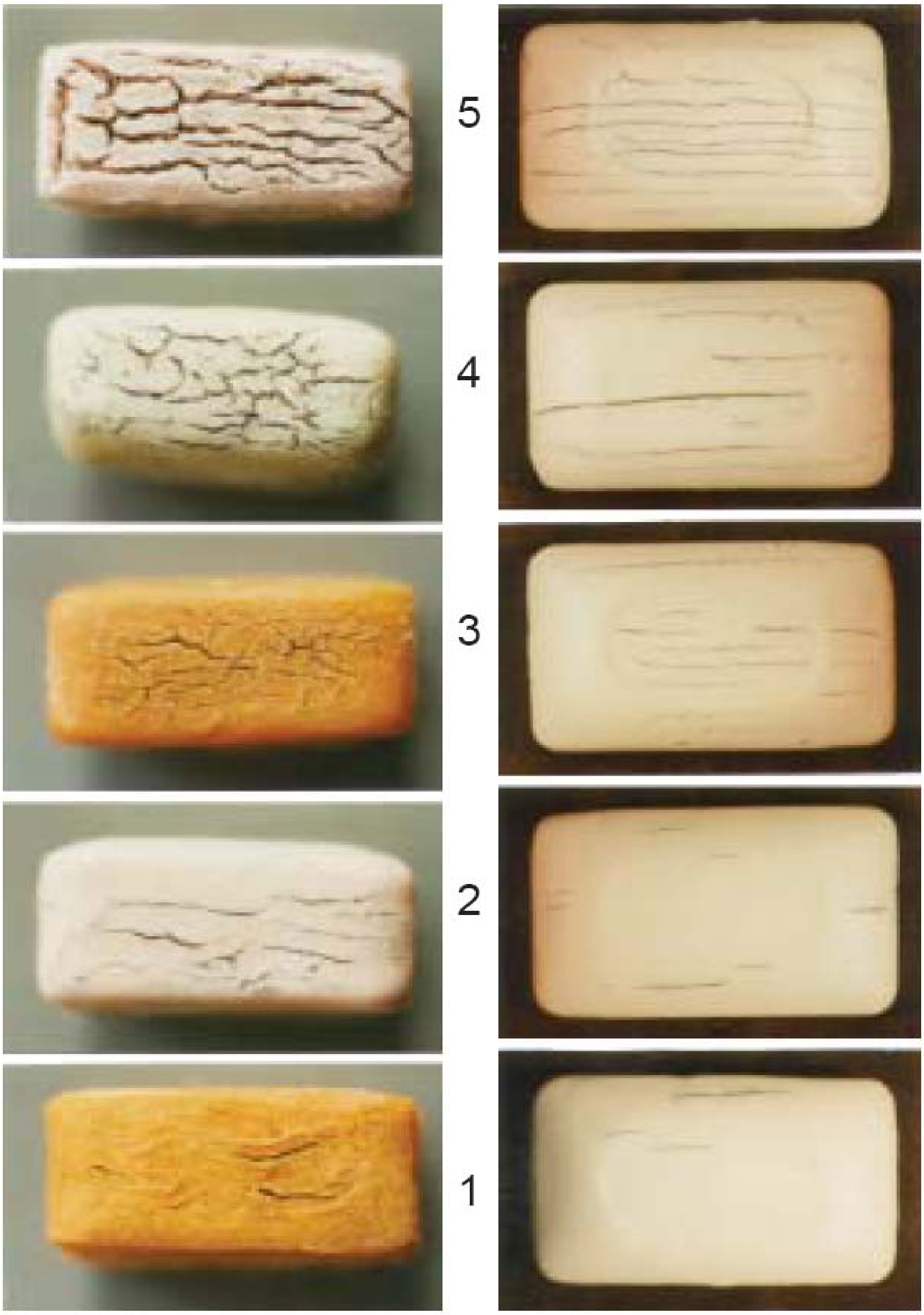
j) **Fatty acid chain length distribution**: in general, an increase in shorter chain length fatty acids tends to reduce cracking by increasing the liquid crystal phase and thereby promoting higher candle to candle adhesion. Similarly an increase in proportion of unsaturated fatty acid content of oil (Iodine Value) will also increase the liquid crystalline phase and therefore reduce cracking. The plasticity of the soap during plodding is improved and cracking is reduced.

k) **Free Fatty Acid content** : Low levels of free fatty acid can reduce cracking by increasing liquid crystalline phase and thereby plasticity of the mass. For higher glycerine soaps they also contribute to increased hydrophobicity and therefore lower cracking on cycling of wetting/drying. However beyond a point, higher levels of fatty acids increase mush, this mush clings to the soap surface and cracks while drying. Hence the overall impression of soap is of more cracking for higher level of free fatty acids (Superfatted Soaps)

l) **Increase of Moisture content of soap**: As the water content is increased from a normal value of 10-12% to 18% or beyond there is an increase in mush and therefore cracking due to increased water penetration in the bar. Please remember that even though higher moisture initially helps in increasing plasticity therefore reducing cracking but beyond a point the earlier mentioned point predominates and cracking is severe. Any water added in the Mixer stage remains macro-mixed and contributes to heavy cracking

m) **Glycerine content** : increases the hydrophilicity of the bar and therefore invites higher water penetration leading to higher mush. Again on subjecting to wetting/drying cycles this leads to an impression of higher cracking due to the cracking of the dried mush layer. Glycerine also makes the soap harder to hydrogen bonding of free water therefore reduces plasticity during plodding. This also contributes to higher cracking.

Cracking Scale



End cracking scale *Face cracking scale*

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