101, VALLEY FIELD COURT, KOROSHO ROAD, off-Gitanga Road Kobil petrol station, NAIROBI – 00604, P.O. BOX: 23365

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1. Molten polymer management and resin chips formation – the harbinger to efficient molding

1.1. Properties of resin – the polymerization derivatives

1.1.a. The charge concentration around the free radicals and weak spots in the polymeric chains are the major forces of friction in the compound in the molten state and in the copolymerization process as well. The strength of the bonds in the polymer defines the mathematical function of the charge concentrate and the conductance in the substrate of the polymer; more so in the molten state with the progressive change in the enthalpy states of the complex.

1.1.b. The conductance and the strength of the charge concentrate in the static modes increase in intensity with the recycled polymers owing to the fundamental weakening of the bond strengths and the increase in the quantum of the free radicals in the polymer substrates. The frictional increase in the molten flow of the polymer cascades all through a given process in the chip formation as also in the extruder causing significant escalation of the enthalpy states of the complex and a raise in the sensible heat as well. The molten polymer would require substantial work to be performed to overcome the frictional forces and this is the deciding factor in defining the quality of the MFI (molten flow index) of the polymer substrate in the extrusion or the resin chips formation processes.

1.1.c. Non-linearity of the mechanical drives as determined by the states of the MFI of the polymer substrates is the harbinger for generation of harmonics in the system. The quality of electrical drives declines substantially owing to the periodicity and increased frequency of the peak currents that impair the insulation through the high thermal stresses that develop in the system.

Blow molding machinery – conventional models

A. **Constraints for productivity**

1. The **molten recycled polymer** in the extrusion zone needs a significantly **lower temperature** than is achievable at present to improve on the **a) die core temperature , b) cooling and curing cycle timings and c) achieving thermal equilibrium in the extrusion process** and thereby aid in the molten polymer flow consistency

2. The high levels of **surface resistance** in the different grades of recycled polymers caused primarily by the structural orientation of the polymer sites for generating **higher static charges** than the concentrates of the virgin polymers

3. **Frictional heat** gets added onto the inductive heating in the barrel as a consequence of **high surface resistance** enumerated in point-2 above

4. Inherent inconsistency in the surface properties cause the **molten volumes to change** as well thereby **reducing** the aggregation of the **latent heat energy transfer**; in effect the sensible heat as measured by the temperature register an increase way beyond the standards set into the system

5. **Die core temperatures** are registered high and cause **damaging changes in the stress-strain properties of the metallurgy** and consequently the **mold configuration** over a period of time

B. Solutions – productivity-quality challenges

1. Introducing the **polymer slippage lubricants like natural silica** or other relevant synthetic lubricants from the shelves of Shell or Total in the **recycled plastic bath** prior to processing of the **pellets** (PROCESS)

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2. Introducing the **anti static agents** in the **plastic bath** that can effectively **reduce the surface resistance of the molten plastic in the extrusion process** and bring in **thermal equilibrium** right through the passage into the blowing zone (PROCESS)

3. Significant improvements in the **cooling process by registering at least 30% increase on the existing diameter of the water pipes** that are connected to the barrel (MACHINERY DESIGN)

4. Providing a **heat exchanger for the barrel to reduce 15% of the built-up heat** based on the estimation of the total heat in the barrel at full loading (MACHINERY DESIGN)

5. Providing another **heat exchanger exclusively for the die core to ensure that 30% of the transfer heat at peak levels can be eliminated** – this shall not only improve on the **life of the die** but more importantly ensure **dimensional equilibrium of the parison** going into the blowing zone through the accumulators (MACHINERY DESIGN)

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C. **Action Plans**

1. **Source additives** – for anti static agents and slip lubricants from Shell or Total and use them in 0.5%, 1%, 2% and 3% concentration to evaluate the changes in performance levels in the extrusion and finalize on the desired concentration.
2. **Enumerating the actions mentioned hereunder**:

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Blow Molding Machine - X01- Analysis for actions

Priority No.	Parameter	Observation	Probable root cause	Impact on the product quality	Impact on the productivity	Remedial steps
1	Mold - consistency of flow	Barrel zone-2 temeprature is higher than the set point of 170 by 15-22 degrees celsius	Screw conveyor problems related to surface and drives	Rejection becomes high owing to incompatible mold temperature and length	Approximately 25% reduction in productive time	A. **Alignment of screw** and **minimization of the lateral play**
		Barrel zone-1 is consistently matching the set point 160 degrees celsius -3 degrees celsius				B. **Hopper connects** overhaul
		Barrel zone-3 is varying between 165 degrees celsius and 175 with a set point of 170 degrees celsius				C. Mold volume reduces in Barrel zone-2 - the screw pressure **(to be adjusted through a combination of screw speed and profile retention)** in driving the molten mold is vital for analysis and rectification

2	Accumulator - mold temperature	Die core is 7 degrees higher than the maximum permissible limits of the OEM - this high temeprature is caused by reduced flow density - the optimization of lowered operating temperature in the barrel through higher surface area would bring in enhancement in the flow density as also on the consistency of the properties right through the accumulator meriting higher productivity through a shrp reduction in the cooling and the curing time	Synchronization between the barrel flow volume and speed and that in the accumulator is lacking - caused by screw conveyor speed-machine flow speed mismatch	Step-wise cooling into the die core area is affected in the material causing differences in molded prouct properties of tensile behavior and possibilities of leakage		A. Overhaul of the **hydraulic system** for actuating the cylinders - to improve on transmission cycle efficiency B. Alignment - **lateral as well as vertical** to ensure mold characteristics in the **die core and minimized vibration to maintain the mandrel position** C. **Anti-static additives** need to be added into the **oil bath** to ensure that the **oil flow consistency is improved and contaminants in the system are reduced** to improve on frctional

						properties of the oil
3	**Quality tracking**	**Leakage test**	**Monitoring shall begin after thecompletion of the above actions - approximately 6 -7 hours downtime is required with 5-6 skilled hands**			
		Tensile test				
		Dimensional and weight tests				
4	**Production tracking**	**Production**				
		Rejects in number with causes				
		Rejects % by weight on production				
5	**Machinery quality index**	**Screw motor energy evaluation**				
		Hydraulic pressure				
		Oil leakage				
		Barrel - Temperature				

		consistency	
		Accumulator - Temperature consistency	
6	**Overall equipment efficiency**	**Machine down time**	
		Rejects % by weight on production	
		Speed V/S technologically feasible speed	

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The blow molding industry requires design changes and corrective measures in the process as enumerated above for efficient operations.

Submitted by:

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