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| --- | --- | --- | --- | --- | --- | --- | --- |
| **1.0 Scope** | | | | | **2.0 Resource Required** | | |
| **1.1 Purpose:** Temper glass as per customer requirement  **1.2 Area of Application:** Tempering line 6,7 and 8*.*  **1.3 Responsibility:** Tempering Machine Operator.  **1.4 Accountability:** Tempering production head. | | | | | **2.1 Man:** Tempering Machine Operator, Manpower.  **2.2 Machine:** Tempering Furnace.  **2.3 Material:** Grinded/Coated/ Drilled/Printed glass, Sulphur Dioxide gas (SO2). | | |
| **3.0 Terms and Definition** | | | | | **4.0 Key Performance Requirements** | | |
| **3.1 Tempering:** Process to heat the glass up to 720-degree approx. and then sudden cooling to increase glass strength up to 5x. | | | | | * 1. **Quality:** Glass should be fulfilled with all quality parameters regarding tempering process like general bow, edge lift, local bow, fragments, mechanical strength, transparency which can make glass easy to fit into solar Module.   2. **EHS:** Dust pollution, cut injury, burn injury, high noise. | | |
| **5.0 Frequency** | | | | | **6.0 Competency Enhancement** | | |
| **5.1** During production and when required**.** | | | | | **6.1** Training over tempering machine operations to be given to all tempering machine operators.  **6.2** Visual posters are to be used for communication. | | |
| **7.0 Procedure** | | | | | | | |
| **7.1 Sequence of Operation** | | | | | | | |
| **7.1.1** Check all the surrounding boundaries of the tempering machine. | | | |  | | | |
| **7.1.2** Turn on the power from the main panel after receiving approval from the electrical department. | | | |  | | | |
| **7.1.3** Check whether the driving belt fits properly on the ceramic roller’s driven shaft and pulley or not.  Also, check the rotation of all the bearings of the driven and driving shaft.  **Belt drive movement direction** | | | | **Belt drive movement direction** | | | |
| **7.1.4.** Check the condition of the Kevlar rope of the roller in the quenching and cooling section.  *Note: If it is found damaged, then it needs to be replaced before the operation starts.* | | | |  | | | |
| **7.1.5.** Check properly whether the nozzle of quenching and cooling section are free from cullet are not.  *Note: If it is found, then clean the nozzles.* | | | |  | | | |
| **7.1.6.** Close both quenching & cooling by pressing the exact same button as shown in the figure alongside from the control panel | | | |  | | | |
| **7.1.7.** Now start furnace, quenching & cooling roller drives from main drive panel. | | | |  | | | |
| **7.1.8.** Check whether the ceramic roller rotates in same forward direction or not. | | | | **Arrow direction is the Forward Direction Movement** | | | |
| **7.1.9.** Now close both sides doors below furnace for safety purpose. | | | | **Doors** | | | |
| **7.1.10.** Check SO2 cylinder valve is properly closed or not. | | | | **Knob** | | | |
| **7.1.11** Now start furnace with a firing rate of 2 % : | | | | | | | |
| 1. From the zone – 01 to zone – 12 as shown in the figure alongside. | | | |  | | | |
| 1. From the zone – 13 to zone – 23 as shown in the figure alongside. | | | |  | | | |
| **7.1.12** With the increasing temperature in all zones firing rate also increases manually as per 10-20-30-40-50 to 100 %. | | | | | | | |
| 1. First & Second Zone | | | |  | | | |
| 1. Third Zone | | | |  | | | |
| * + 1. Now start all the blowers from the control panel. | | | | | | | |
| 1. Quenching Bottom Blower   *(Press the same button to start quenching bottom blower).* | | | |  | | | |
| 1. Quenching TOP Blower   *(Press the same button to start the quenching top blower).* | | | |  | | | |
| 1. Cooling Blower.   *(Press the same button to start the cooling blower).* | | | |  | | | |
| **7.1.14** Now start loading conveyor table by button given on HMI table. | | | | | | | |
| 1. Now start loading conveyor table by clicking or pressing the button given on HMI of furnace**.** 2. Now, take dummy trial by sensing inlet sensor.   *NOTE: - In dummy trial we must check blower increasing as per blower frequency speed set point, glass furnace in & out time is proper or not.*  *If all found ok in dummy trial, then take a trial with actual glass*.  *Note: During loading of glasses make sure the alignment bar is working properly, and the glasses are entering the furnace in full straight path and there is no other any misalignment.* | | | |  | | | |
| * + 1. The following points need to be checked at the time of dummy trial. | | | | | | | |
| 1. Furnace ceramic roller drive issue alarm. 2. Quenching and cooling transmission error alarm. | | | |  | | | |
| 1. Glass does not transfer furnace to quenching. 2. Sensor indication. | | | |  | | | |
| 1. Size input in HMI 2. Broken glass particles on conveyors | | | |  | | | |
| * + 1. Size setting (PL-06, 07 and 08) and line selection (Only applicable at PL -08). | | | | | | | |
| 1. Now put the glass size in HMI panel which we must run in the tempering machine. 2. Select the line whether it can be ARC or Laser Drilling or Laser Drilling with Grid Printing line only applicable at PL-08. 3. Select either ARC or Laser Drilling (LD) or Laser Drilling with Grid Printing (LD+GP) from the line selection in HMI.   *Also enable the flipper by clicking* ***Enable Flip Device*** *for grid printing production.* | | | |  | | | |
| * + 1. Emergency Switches.   Check all the emergency switches whether they are open or not. | | | |  | | | |
| * + 1. Sensors.   Clean all sensors before glass load from grinding to tempering machine. | | | |  | | | |
| **7.1.19** The following details should be checked before operating the Tempering Machine. | | | | | | | |
| 1. Check the condition of line selection whether ARC or Laser Drilling line at PL-08. 2. After ARC all accumulators should be in auto mode and same for the Grid Printing section. | | | |  | | | |
| 1. Check the proper movement of glass from the selected line. 2. Check the drilled hole and grid printed ink condition visually before glass entering furnace. | | | |  | | | |
| **7.1.20** Sample trial.  Load 4 to 5 glasses for sample trial. | | | |  | | | |
| **7.1.21** Check the glass safely came out from furnace to quenching & cooling section then came to quality checking table. | | | | | | | |
| 1. Furnace to quenching section. | | | |  | | | |
| 1. Quenching to cooling section. | | | |  | | | |
| 1. Cooling to quality sorting table. | | | |  | | | |
| **7.1.22** After ball drop test is done successfully, do check all glass quality parameters | | | | | | | |
| 1. Ball Drop Test   (Only applicable to 3.2 mm thick glass during running line production and during quality sample testing).   1. General Bow 2. Edge Lift 3. Fragmentation 4. Local Bow 5. Mechanical Strength | | | |  | | | |
| **7.2 Special Tools Requirements** | | | | | | | |
| **7.2.1 Cullet Cleaning Tools for Furnace**   1. Glass Breaking Rod (*Used in emergency*) 2. Furnace Cullet Cleaning Rod (*Used for emergency or general purpose*) | | | | Furnace cullet cleaning rod  Glass breaking rod | | | |
| **7.2.2** Cullet Accumulating Rod | | | | A long metal object on a concrete floor  AI-generated content may be incorrect. | | | |
| **7.2.3** Cullet Remover Spade | | | |  | | | |
| **7.2.4** Heat Resistance Hand Gloves | | | |  | | | |
| **7.2.5** Ceramic Roller Holder | | | |  | | | |
| **7.2.6** Ceramic Roller Remover Slider | | | |  | | | |
| **7.2.7** Fire Extinguisher | | | |  | | | |
| **7.3 Prevention & Detection Controls** | | | | | | | |
| **7.3.1** Continues monitoring the DCS for any alarm for power fail or drive fail  **7.3.2** Monitor for glass breakage inside furnace or quenching zone. | | | | | | | |
| **7.4 Controls Related to EHS** | | | | | | | |
| **7.4.1 PPE MATRIX** | | | | | | | |
|  |  | |  | | | | **A pair of white quilted pants  AI-generated content may be incorrect.** |
| **Goggles** | **Safety Shoes** | | **Hand Gloves** | | | | **Arm Guard** |
| **7.4.2** Broken glass needs to be disposed of in cullet bag only which is near the dump conveyor at tempering loading and after the cooling section. | | | | | | | |
| **8.0 EHS Compliance Obligations** | | | | | | | |
| **8.1** NA | | | | | | | |
| **9.0 Possible deviation & Impacts** | | | | | | **10.0 Proposed actions** | |
| Please refer to SOP for troubleshooting of the tempering furnace 6, 7 and 8.  SOP No. – TEMP/L3/XXX | | | | | | Please refer to SOP for troubleshooting of the tempering furnace 6, 7 and 8.  SOP No. – TEMP/L3/XXX | |
| **11. Reference documented information** | | | | | | | |
| **11.1** Tempering Logbook Document No. – TEMP/L4/011 | | | | | | | |
| **12. Revision History** | | | | | | | |
| **Revision No.** | **Date** | **Description of changes** | | | | | |
| 01 | 02.10.2025 | Format revised, clauses 2,3,4,9,10 &12 added.  Also, picture has been added. | | | | | |
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