⑥ Internship Activities

The summer training initiated with a regular orientation program, dedicated to all trainees in the plant by the Training Department belonging to the Human Resources Directorate. The program consisted of a general introduction, three presentations regarding the standards achieved by the company in various branches of occupation, and a guided tour of the plant. In the general introduction, the organizational structure of Şişecam and Anadolu Cam were explained, the units and steps of production in the factory were discussed and the training rules were mentioned of. In the following presentations, it was divulged that the Toptaşı Plant has obtained ISO 9001 Quality Management and Nutritional Safety Management, ISO 14001 Environmental Management and OHSAS 18001 Occupational Health (Working Safety) Management documents. Finally, during the guided tour of the plant, the working principles and significance of the following departments were discussed: Batch - Furnace, Production, Mechanical Maintenance and Repair, Mold Repair and Production Planning.

Together with a professional guide from the Training Department, I established my 20-days training program such that it contains all the departments constituting step by step the production line. According to this program, I would be able to observe the entire production flow from the very beginning of raw materials stage up to partaging and storage. Surely, greatest weight was given on the Batch-Furnace and the Production Departments, which account for the most important first five steps out of nine on the production line, namely the process of forming glass containers from raw materials.

Having established my training schedule, I commenced working in the Batch-Furnace Department, which constitutes the initial steps of production in the plant. Although the batch unit and the furnace unit serve different functions following each other on the production flow (furnace being the follower), they are united under the roof of the Batch-Furnace Department.

Before beginning a detailed explanation of what I learned and accomplished in this department and in the following schedule, an over-view of the production system and a discussion based on the materials needed during the manufacturing processes in the factory are in place.

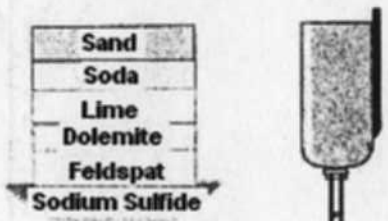
Production flow in this factory is divided to have nine main steps, an overview of which is provided on the sketch below. The first step, namely the batch preparation, illustrates the main families of raw materials utilized in production. These are: sand, soda, lime, dolomite, feldspat, sodium sulfate, colorants, decolorants and glass fragments. More detail on the raw material families and provision will follow later in the section. For the sake of clearness; batch is defined as the mixture of raw materials building glass. Feeding the furnace with the prepared batch establishes the second step, whereas the third and fourth steps are related with different sections of the furnace. Observations and knowledge regarding the operation of the furnace will be presented later in the section. All the four steps overviewed up to this point are in the scope of the batch-furnace department, which proves its significance on the production flow.

The fifth step of production, namely forming of glass in IS machines, is the most important one. Here; gobs (drops) of molten glass are fed from the furnace sequentially to the independently operating units of the IS machines, where they are formed into glass containers in special molds with the help of computer-controlled pneumatic mechanisms.

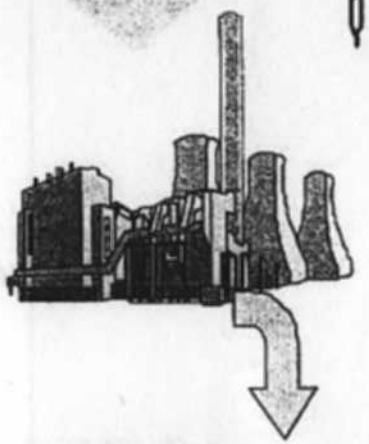
PRODUCTION FLOW

KISIM / SECTION :	Yaprak No / Page No : 7
Yapılan İş / Work Done :	Tarih / Date :

1. Batch Preparation



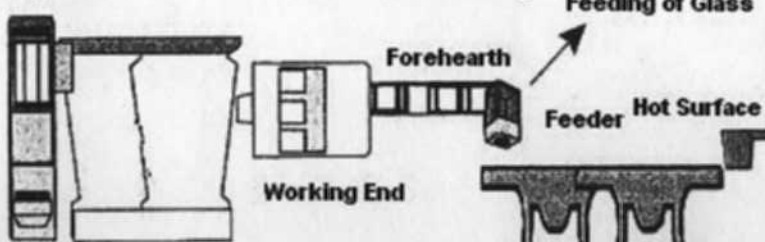
Colorants, Decolorants
Glass Fragments



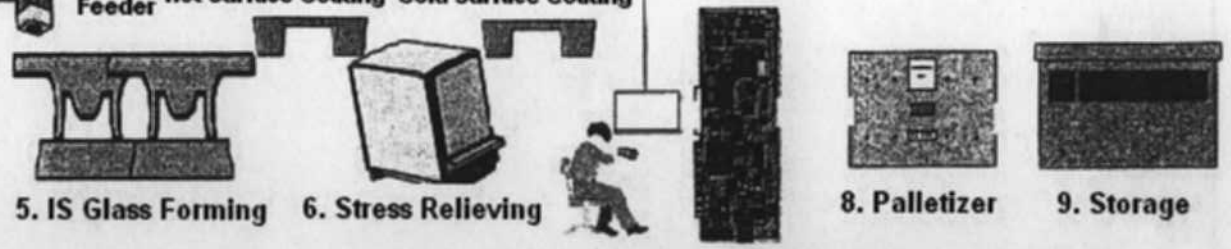
2. Feeding the Furnace

3. Melting End

4. Glass Conditioning



Manuel Separation



5. IS Glass Forming

6. Stress Relieving

7. Inspection Machines

8. Palletizer

9. Storage

Anadolu Cam Sanayii A.Ş.
Topkapı Fabrikası

There exist four furnaces, A, B, C, D and fourteen production lines extending from these. Each production line has an IS machine with several sections. IS means "individual section", heighlighting the independent working principle of the glass forming sections belonging to the machines. The fifth step comes to an end with the hot surface coating of the newly formed bottles. Surely, there exists an enormous mass of technical knowledge I have gathered from instructors about the working principles and operating conditions of all the machinery and auxiliary equipment belonging to the production step, which will be presented in full detail in the following discussion.

Three types of manufacturing techniques are utilized in glass forming, which differ in the manner of producing an intermediate glass called the parison before giving the bottles their final shapes. These techniques are BB (blow&blow), PB (press & blow) and NNPB (narrow-neck press &blow); a detailed discussion of which is also provided in the text.

The remaining steps of production are under the scope of the Cold End Department, which accounts for the stress relieving and cold surface coating of bottles, their quality checks implemented both manually and by inspection machines, and their packaging and storage. In the sixth step, the glass containers are gradually cooled and stress relieved in computer-controlled oven zones and they are cold surface-coated. In the seventh step, imperfect products are determined and removed by automatic inspection machines, and they undergo the eighth step of packaging on palletizers. The final step is storage, where the glass containers are transfered via a network of conveyors to their places in the huge store.

Anadolu Cam Sanayii A.Ş.
Teknik Resimler

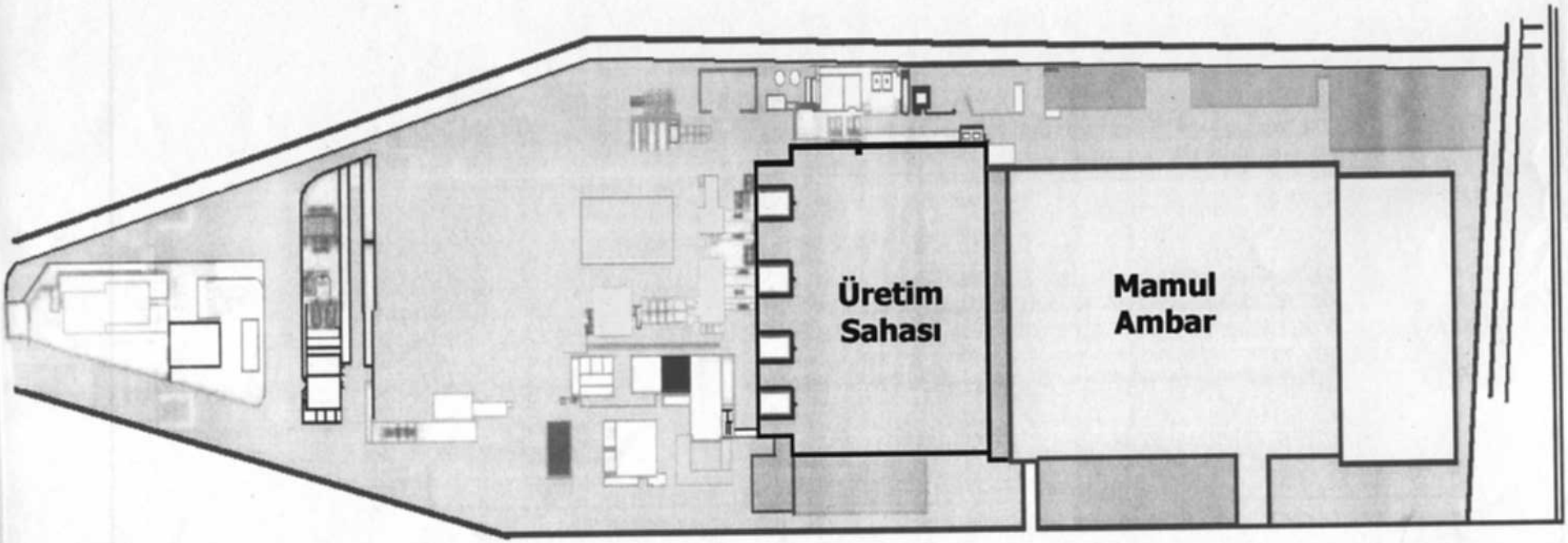
As the resources and inputs are already mentioned of, it is to discuss the constraints of the production system. The limiting factor for the production system is surely the operating speed and efficiency of the IS machines. The batch is continuously fed from huge stores and the capacities of the furnaces exceed 50 000 tonnes. Also, the melting rates are all greater than 170 tonnes per day. Furnaces A and C provide sufficient amber molten glass (brown-yellow color of beer bottles) and furnaces B and D provide sufficient flint molten glass (colorless) for any reasonable production rate of IS machines. Hence, the speed and efficiency of IS machines determine the limit for production. Speed values depend on the weight of the bottles and range between 100-200 bottles per minute. Efficiency values range between 80-90%. Production never ceases, as a critical drop in furnace temperature results in a permanent loss of its functionality. An efficiency increase of one percent would correspond to millions of dollars; hence, the endeavours of mechanical engineers are of greatest value in this factory.

The factory layout (its only authorized version) is provided below.

Arçelik Cam Sanayii A.Ş.

ANADOLU CAM TOPKAPI FABRİKASI

ŞİŞECAM



129,000 m²

Anadolu Cam Sanayii A.Ş.
Topkapı Fabrikası

KISIM / SECTION :	Yaprak No / Page No : 10
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KISIM / SECTION :	Yaprak No / Page No : 11
Yapılan İş / Work Done :	Tarih / Date :

My work in the Batch-Furnace Department initiated with a detailed analysis of the raw materials and their provision. My instructor, Cüneyt Kumru, who is the Chief Engineer in the Batch-Furnace Department, gave me the following knowledge about glass composition and raw material provision: Gloss is mainly composed of of 72 % SiO_2, 14 % Na_2O, 12 % $CaO + MgO$ and 2% Al_2O_3. In Turkey, twenty percent of raw material amount is provided from recycled gloss fragments. I learned that this percentage reaches ninety percent in Japan! Resources containing these raw materials needed for batch preparation are the following:

- Sand : SiO_2, Al_2O_3 → extracted in Yalıköy
- Dolomite: CaO, MgO → extracted in Trakya
- Feldspat, Pearlite or Feldspathoid Sand : SiO_2, Al_2O_3, K_2O, $Na_2^{\bullet}$, CaO
- Soda : Na_2O → synthetized in Mersin and Varna.
- Lime : CaO, MgO → extracted in Trakya
- Recycled gloss fragments
- Additives :
  - # Affination Materials : Sodium Sulfate
  - # Colorants (Pyrite, Anthracite, Sulfur, Chromide etc.)
  - # Decolorants (Cerium Oxide, Zinc Seleneide, Cobalt Oxide)

All the resources except soda and additives are natural, which accounts for the biological and nutritional safety of gloss products.

I viewed step by step the entire batch unit under the guidance of one of the coworking batch engineers : Ayşe Yavuz
I observed the operation of all these steps and learned the technical details as well as working principles accompanied with these steps.

Anadolu Cam Sanayii A.Ş.
Öğrenci Eğitimleri

The raw materials being brought from auxiliary companies are transferred with trucks into closed hangars separately. Long conveyors transfer these materials to storage silos of 2000 tonnes capacity. Afterwards, they are further transferred upwards, to the service silos of 45 tonnes capacity. The mechanism of this transfer differs, however, based on the type of raw material. White sand, yellow sand and recycled glass fragments are transferred with motor-driven buckets whereas soda, dolomite, lime and feldspat are pumped upward by pneumatic systems of 6 bar pressure. The so-called melange, which is a general term used for additive materials such as colorants and decolorants, is bought and transferred in sacks.

After each raw material has been transferred to the corresponding service silo, they are sent to weighing tanks via conveyors, where the amounts dictated by the so-called receipts are precisely weighed and sent to mixers. The receipts are established by calculating the composition of the glass container to be produced. The composition depends on the desired hardness, strength, thickness, color and light permeability. The batch is homogenized in the mixers by circulation and sent to furnace silos adjacent to the furnace itself. Before reaching the furnace silos, the batch is mixed with the glass fragments and goes through magnets and separators. From furnace silos, the batch is fed to the furnace. By definition, one batch corresponds to 4 tonnes of raw material with glass fragments.

Prior to weighing, the humidity of raw materials is measured by taking average values corresponding to specimens taken from various sites. A maximum humidity of 8 % is allowable in batch preparation.

The whole process up to the feeding of furnaces is controlled with a series of sensors installed to each and every station in the batch unit. Technicians can observe and direct the operation of any tank or silo via computer.

Before beginning my analysis on the furnaces, I took a closer look at establishing receipts. Actually, it was my task to prepare one such receipt. I learned that it is done in the following way:

	%	SiO_2	Al_2O_3	CaO	MgO	Na_2O
Theoretical Glass Composition		71,21	2	10	1,6	13
Sand	A	97,6				
Feldspat / Pearlite	B	74	12,7			3
Dolemite	C			31,6	20,5	
Lime	D			54,5		
Soda	E					58,5

For each column on the table, an equation can be written as:

1. Column: $$71.21 = \frac{A \cdot 97,6 + B \cdot 74}{A + B + C + D + E}$$

The obtained five equations can be solved to yield the unknown percentages A, B, C, D, E ; which I have accomplished in MATLAB as I have learned in ME 303 course.

In my last days in the Batch-Furnace Department, I accomplished a thorough technical analysis of the furnaces. In order to do this, I went to the furnace control room with the same batch engineer. She explained me that the furnaces have three important parameters to control:

• Temperature: The temperature value differs in various sections of the furnace between 1150°C and 1500°C. It is measured with thermocouples and checked steadily to have the desired value.

• Pressure: It must be always below a critical value to avoid an explosion.

• Level: The molten glass level must have a constant values since it affects the flow rate of the exiting glass. It is measured by laser or mechanical systems at the exit and fed back via control signals to the feeders of the furnace. If the level drops, the batch amount being fed into the furnace per unit time is increased, or vice versa.

From the guiding engineer, I gathered the following knowledge about the structure and operation of the furnace:

On the sidewall of the furnace, there exist regenerators made from refractory materials, which are connected via several ports to the inside of the furnace. Through the ports, natural gas is injected and exhaust gases are removed. Batch is provided from the furnace silos via feeders. Except these units, the furnace has four regions: The first is the melting end where the temperature is a maximum and where the batch melts into glass. The arising water and CO_2, as well as dissolved air are removed by transferring the melt to a region having a lower ground level over a bridge wall. The bridge wall provides a better circulation and homogenization. It also creates convection currents contributing to the removal of air. Besides, it hinders the passage of any solid batch to the following regions. The removal of gas bubbles can be facilitated by bubblers producing convection currents. Only the furnace B utilizes such bubblers among the furnaces A, B, C, D. The homogenized and bubble-free glass is transferred through a throat to the working end where it is cooled and distributed. Finally it passes through a throat-like channel termed the forehearth to the exit where it is again circulated and pressed down with a plunger to leave the furnace. As soon as it leaves the furnace, it is the concern of the production department.