The description of the main technological processes
Ust-Puiva

The excavated material (quartz ore) from the mines (Dodo, Hoos-Oika, Nester-Shor) will be delivered by dump-trucks (tonnage up to 20 t) to Ust-Puiva. The annual amount of delivery is estimated as approximately 24000 t. Quartz excavations and transportation to Ust-Puiva will take place from June to September during 112 days of the year.

The mined quartz lumps with the size up to 400x400x400 mm will be fed from the trucks directly to the hopper of an apron conveyor with a storage capacity of 30t and then transferred to the first jaw crusher with a capacity of 15t per hour. Here the material will be crushed down to 100mm. The next stage will be secondary crushing in another jaw crusher with a narrower gap width (20mm). After the second crushing stage the distribution of the main fraction will look like the following: 25-35mm-19.1%, 16-25mm -37.6%, 10-16mm -13.7%. After the second crushing stage the quartz will be washed in a washing drum. During the washing some dirt from the surface of lumps and material <0.5 mm will be removed; manganese and iron coatings will also be partly washed out. Then, after the second crushing and washing, the quartz material will be placed on dewatering screen and divided into four fractions. The fine material (below 3mm) initially was supposed to be stored without preliminary optical sorting. The fractions 3-10 mm and 10-25mm will be passed through an optical separator and material >25mm will be recirculated to crushing. During the optical separation the coloured particles (including schist, coatings of manganese and iron hydroxides) will be separated from the crushed ore. The fine fraction (<3mm) will be subjected to dry magnetic separation which will help to decrease the level of contamination (the problem is being studied).
After crushing and sorting into fractions <3mm, 3-10mm and 10-25mm, the half-finished quartz product free of surface contamination and rocks will be dried and then packed in bags (1.5t) and transported to a storehouse. The necessity of drying is dictated by the situation when the wet ore put in plastic bag will be coated with iron oxide due to the presence of iron contamination during the crushing. The moisture in bags (1.5t) with quartz ore would provoke the freezing of the stack at Ust-Puiva storehouse at the time when the quartz is to be transported to Saranpaul. The crushed quartz ore packed in bags 1.5t will be stored in two cold mechanized warehouses equipped with catheads with a lifting capacity of 3,2 t.

Saranpaul

From Ust-Puiva the material will be delivered by lorries to Saranpaul where it will be stored in two cold mechanized warehouses equipped with catheads with a lifting capacity of 3,2 t. Then, in the high water period, the quartz will be transported by river to the port of Sergino and farther on by railroad (50km) to the town of Nyagan where the high purity quartz processing plant will be erected.

Nyagan (dry grinding version)

The crushed ore delivered from Ust-Puiva is fed into the feed hopper (with a capacity of 4.5t) of the processing plant and then is sieved at a mesh size of 8mm; whereupon the fraction >8mm is fed to the roll crusher.

After crushing the material is sieved at mesh size 8mm. The particles >8mm are fed to the roll crusher again. The feeding to the next comminution step is done by a weigh feeder. This unit will be needed for a constant feed rate to the grinding circuit and to control the mass flow. The first step in the grinding circuit is the separation of the fraction <0.3mm by sieving. The overflow of the screening machine (0.3-0.8mm) is fed to the vertical shaft impactor. In order to decrease the amount of fines <100µm the rotation speed of the grinding machine is reduced. The quartz product from the vertical shaft impactor is conveyed back to the sieving at 0.3mm. The underflow of the screening machine is placed in a feed bin with a storage capacity of 5t. The controlled feeding to the subsequent sieving stage is done by weighfeeders that deliver the fraction <0.3mm to the tumbler screening machines. The fines (<100µm) separated during sieving will be stored in a 80t silo. The product fraction 0.1-0.3mm is stored away in the feed bin prior to the magnetic separation stage. From the feed bins the material is fed to the conveyor belt, where five steps of magnetic separation are conducted. After the fifth magnetic separation stage the quartz particulate is filled into transportable silos that will be transported to the chemical treatment plant by a fork lift. The magnetic impurities separated during the magnetic separation are transported pneumatically into a silo with a capacity of 80t. The silo should be emptied once a week. During the magnetic separation treatment representative samples should be taken in order to check the quality of the product for the subsequent chemical treatment. During transportation, sieving, crushing, grinding and magnetic separation of the dry quartz, dust is produced. Therefore, to prevent dust contamination, all these processing steps have to be equipped with closed housing and kept under a slight vacuum. The dedusting plant with a bag house sucks off the dusty air from all the machines and separates the dust in the bag house. The dedusting should be done carefully to avoid separation of the product fraction >100µm. The level of impurities in the quartz particulate after the dressing operation is still higher than that specified by the commercial requirements for high purity quartz sand. The level of impurities can be lowered by a multi step leaching operation. The containers with the analyzed and qualified sand are transferred from the storage area to the production area with a fork lift and then positioned on the conveyor belt scale with a crane. The sand is charged batchwise from the container into the corresponding reactor via the conveyor belt scale and the distribution belt. During this operation the exact weight of the sand entering the reactor is determined and recorded. Hydrofluoric acid leaching is performed on two parallel production lines in double cone reactors with a capacity of up to 3.75 t quartz sand per batch. After the leaching in the reactors the continuously moving material is washed. After finishing the acid leaching cycle and the single stage washing operation, the remaining acid concentration is further reduced by a five steps counter current washing cascade. For that, near every leaching reactor a set of four intermediate storage vessels is installed. The liquids are pumped from the reactor into the storage vessels with hose pumps. After that, the batch is washed with fresh demineralized water. After the washing operation the solid material is discharged into the dosage vessel partially filled with water. After the discharge of the solid material the reactor is brought back to the running position. Then the product is classified. The classification system comprises a dosage vessel, a dosage pump and a conventional counter current classifier per production line.

During the classification operation additional demineralized water is poured directly into the classifier. The quartz sand slurry generated during classification flows continuously from the classifier to the filtration unit. Separation of the water from the classified slurry will be performed on one conventional belt filter per production line. The belt filter consists of a set of vacuum chambers with a filtration belt passing continuously above the chambers, a vacuum pumping system and a filtrate pumping system. From the belt filter the solid material is continuously discharged into the dryer. The water content of the filtered material will be separated by evaporation. For this purpose the filtered material is fed into a static vertical dryer with quartz elements of direct contact heating. The dried material will be discharged continuously into a product container until the charging is completed. Then a certain part of the dry material may be calcined at high temperature (up to 1600ºC) in ceramic tubes in order to decrease the content of gas-liquid inclusions. Furthermore, some amount of the material will be subjected to high temperature chlorination. During the chlorination a significant part of alkaline impurities (Na, K, Li) will be removed. After chlorination or calcining the material is sieved in order to break agglomerates and to separate the coarse and fine fractions so that only grains of the specified size remain. The material will be sieved batchwise on one conventional multistage sieving machine per production line. The machine produces three fractions - coarse fraction, main fraction and fines. Each machine will be connected to a central dust collection system (one per production line). The main fraction coming out of the sieved machine is automatically sampled with a mechanical sampling system in order to obtain an average sample from every batch as soon as the batch is completely processed. The quartz fractions are stored batchwise in containers. The packing system comprises one semi-automatic feeding, dosage and weighing system with a capacity of up to 5 t/h per production line. The product container is placed on top of the feeder using either a fork lift or a crane. The concentrates are packed into fiber drums with a capacity of 80 to 200 liters.

The drum is positioned manually on the roller conveyor and the feeding system is started. The system stops once the required weight is achieved. The drum is then removed manually from the roller conveyor, marked, closed and placed on a pallet either by a crane or by a fork lift. It is essential to store the final product in a clean room with good access to the production area and to the external transport area. Sometimes it is quite possible to obtain a product equal to IOTA Standard directly after magnetic separation. Nonetheless, depending on raw quartz quality, in some cases it will be necessary to perform chemical treatment to achieve IOTA Standard. IOTA 4 quality of quartz concentrate will be reached after an additional leaching of IOTA Standard samples. To produce IOTA 6 from IOTA 4, calcination and high temperature chlorination are necessary. Besides, the calcination of the material designed for quartz glass production will require more time and more energy than the calcination of the material for quartz crucible production. The final product will be packed in fiber drums. At the processing plant, a special drum production line will be created. As any production with the use of chemical reagents, the quartz processing plant will be provided with neutralization facilities where all waste water will be neutralized and purified to the required level and then disposed to the sedimentation pond and to the municipal sewer system.

Transportation of quartz raw material and semi-processed product

The quartz raw material will be delivered in three stages:

1) By freight transportation - from the deposits to Ust-Puiva. Polar Quartz is planning to transport the quartz raw material from the quarries of Neroika deposit to the processing plant in Ust-Puiva (average distance between these points is about 60 km). Dodo, Hoos-Oika and Nester-Shor are connected to Ust-Puiva by earth roads that can be used in summer (for about 3,5 months). The raw material will be transported in lorries with a capacity of 20 tons. Each lorry will work in two shifts and make 3 trips a day - from the quarries to the plant and back. The calculation was based on the following data:

- Average traveling time from Ust-Puiva to the quarries is 1,5 h.
- Average loading time is 45 min for each lorry.
- In a season, 20 000 tons of packed ore accumulate at Ust-Puiva.
- The quartz can be transported to Saranpaul during the 154 days since early November till early April (taking into account the 30 days of snowstorms when the quartz cannot be transported, 42 days of good weather and 82 days of bad weather). - Average travelling time in good weather is 1,5 h, in bad weather - 3 h. - In good weather the quartz is transported in two shifts, in bad weather - in one shift.

2) Further the quartz is transported from Ust-Puiva to Saranpaul in lorries. Now Ust-Puiva and Saranpaul are connected by a highway of the 4th category. The new highway can be used almost all year round - with the exception of the spring and autumn floods, freezing-over and ice drift (about 3 months), when it is difficult to cross the rivers.

3) By river from Saranpaul to Sergino. The river is navigable for barges with the planned capacity of 3000 tons only in the high water time that occupies about 60 days since May till July. To organize temporary storage of quartz ore it is planned to build mechanized warehouses similar to those in Ust-Puiva.

To load the ore from the warehouse to the barges, a river wharf equipped with necessary handling machinery is planned to be built. The planned type of transporting vessel is a coupling of two 3000-ton barges moved by a towboat. The presumed fluctuation of water level in the given place is 6,0m. It is planned to perform all the technological operations in Sergino (reception, reloading and dispatch of quartz ore) using the existing powers (?), buildings, installations and equipment.

Transportation of bought feed and materials

Feed and materials will be delivered by railway from the suppliers to Nyagan's industrial site on the territory of the plant. The delivery cost of other types of feed, materials and component parts will make up a small part of expenses for transportation of HF and lime.

HF will be transported in tanks with a capacity of 15 m^3 placed in freight wagons (when delivering from Perm or Kirovo-Chepetsk).

After HF is used, the containers in which it has been transported will be returned to the producer factory by the same road as HF.

Due to the rigid requirements to the quality of HF, a technological reserve (50% of monthly intake) will be created; therefore, HF will be delivered twice a month in 5 wagons (60 tons), each of them containing 4 tanks with a capacity of 15 m^3.

The lime will be delivered in the quantity of 20 wagons a month.

HCl will be delivered in the quantity of 1 wagon a month.

Thus, 31 wagons a month will be necessary to provide the enterprise with resources.

Transportation expenses (both ways) will amount to € 23 700 a month.

Transportation of quartz concentrate to the consumers

The quartz concentrate will be transported to the consumer by railway directly from the plant's production site. The main destinations will be:

- Europe (Hamburg);
- Far East (Hong Kong);
- Russia (Saransk, Gus-Khrustalny, Skhodnya, Podolsk).