At the Leningrad "Farmakon" Chemicopharmaceutical Plant many preparations are dried in pneumatic dryers. In designing these dryers provision must be made for the safe operation of the equipment because of possible generation of static electricity. This necessitates a thorough grounding of equipment and of air ducts as well as selection of air feed rates, feeder capacities, and temperature conditions such that the formation of an explosive dust concentration in air and temperatures favoring an explosion are not possible. For this reason, for example, products are washed in water during the crystallization of organic solvents.

The first pneumatic conveying dryer assembled at the plant consisted of a Z-shaped pipe with a constant cross-section. The moist product was charged into it through the lower horizontal section by means of an inclined pan conveyor. A batch feeder was used for batching. Two low-pressure fans (in the pressure and in the suction lines) supplied air to the dryer.

Polydisperse substances, in which the dry particles are from 15 to 800 μ large, are dried in the plant. However, the moist product is a mixture of small lumps of different sizes. This complicates the calculation and designing of the dryer. The moist product is introduced into the feeder in which, inevitably, an additional lumping occurs. The installation of sizing screens at the outlet of the batcher gave no favorable results since additional electricity and strengthening of the structural elements of the feeder became necessary. Apart from that, the efficiency decreased and no absolute reliability could be ensured.

In the modernized dryers the product was no longer fed into the horizontal section, since the moist product stuck to the lower part of the pipe in the place where it was charged. This led to frequent stoppages of the dryer for cleaning. Therefore the moist product was fed into the vertical section of the air pipe.

Worm feeders are now used for feeding and batching the products. These feeders have been found to be simple and reliable.

Usually, pneumatic conveying dryers consist of a vertical pipe with an absorber on top. However, to simplify transportation, the worm feeder was installed near the centrifuges or the Nutsche filters in which the pure products were filtered, and the dried product had to be conveyed to the screen. For this, horizontal sections of considerable length were needed. As shown by experience, no absorbers were needed in the upper part of the pipe-dryer.

**Fig. 1. Diagram of pneumatic conveying dryers for phenobarbital:**

1. filter;
2. electric air heater;
3. screw-conveyor batcher;
4. breaker;
5. expander;
6. cyclone;
7. mixer;
8. bag filter;
9. shaker;
10. fan;
11. catch lever;
12. intermediate hopper;
13. balance;
14. photoelectric switch;
15. pneumatic clamp for bags;
16. centrifuge;
17. vacuum discharger;
18. cartridge filter.

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Pipes of nonconstant cross-section are used in the design. In places where the finished product is charged, the speed of air should be fastest, i.e., 18-20 m/sec. The speed of air should be calculated taking into account the size of the lumps and not the particle diameter. In the vertical section, the diameter of the pipe increases so that the speed of air in it should somewhat exceed the lump-pickup speed. The lump-pickup speed for the products made at the plant is 3-6 m/sec. The small lumps disintegrate and most of the moisture disappears in the vertical, broadened section. Moreover, the main problem is to achieve disintegration of the small lumps into crystals. In the subsequent horizontal section the pipe is again narrower. The speed of air in it is assumed 8-11 m/sec (transportation speed). In this section the product is finally dried.

On operating the pneumatic conveying dryers, it was found that it was advisable to use type TsP6-20 No. 5 fans in which the supply was 2000 m³/h, the pressure 500 kgf/m², and the number of revolutions 2900 per min. The fan was installed in the suction line and not in the pressure line, as usually recommended. This made it possible to completely prevent the dust from penetrating into the premises in case of leakage.

To collect the dried product, TsN-15 cyclones are used. Since the cyclone efficiency for particles of up to 20 μ diam. does not exceed 95%, a bag filter was connected in series. The design of the bag filters was developed at the plant. The working area is 4 m² and the shaker is operated manually.

The method of heating air depends on the temperature required. The maximum temperature is regulated by the mp of the product. However, it should be noted that the moist product in the pipe-dryer begins to melt even before reaching the mp (which is determined by laboratory methods). This leads to a gradual obstruction of the dryer and to the disintegration of the crystals. Therefore, the optimum temperature is determined in the dryer itself by using experimental methods only.

Conventional steam air heaters, electric air heaters, and a combination of steam and electric air heaters were tested. The electric air heaters were developed and manufactured at the plant. The overall dimensions of one block, with a possible and established power of up to 20 kW, are 500 x 500 x 300 mm, and the surface is 20 m². The air heaters are installed in the suction line and equipped with air filters.

It is impossible to produce in the pneumatic conveying dryers a constant residual moisture content, but the crystals can be comminuted. For the products made at the "Farmakon" plant, only the maximum tolerable moisture content is regulated. The moisture content obtained varies from 0.08% (on 4,4'-diethoxythiocarbanilide ["Extoxide"] to 80% (on phenylacetamide). Drying up to some tenths (see Table 1) and even some hundredths percent, which is possible in practice, confirms that it is wrong to assume that it is impossible to achieve such a moisture content in pneumatic conveying dryers. The experiment also confirms that it is wrong to assume that the power consumed on drying in pneumatic conveying dryers appreciably exceeds the power consumed when other drying methods are used. To prevent comminution of the crystals, the speed of air should be as low as possible for a given product, the number of shaped parts in the air pipelines should be reduced, their shape improved, and the pipes of the dryers and cyclones should be made of materials with a smooth surface.

The main units of the dryers (fans, worm feeders, electric air heaters, bag filters) are standardized. The efficiency of the fans and of the worm feeders is controlled by varying the number of revolutions. The electric air heater is assembled from similar blocks. Bag filters with the same standard dimensions are used for all dryers.

With the introduction of pneumatic conveying dryers, the drying capacities at the plant sharply increased. At the same time, the clearing of factory space (drying cabinets which were used for drying previously were no longer in use) made it possible to increase production in general. For example, the drying department for phenacetin equipped with drying cabinets of a 20-30 kg/h efficiency occupied an area of space of 100 m². The pneumatic conveying dryers occupy an area which is substantially smaller. The drying operation in the pneumatic conveying dryers is fully mechanized, and the charging operation of the moist products is also mechanized. For example, Nutsche filters with mechanized discharging devices are used in the drying process of phenylacetamide. These filters are directly unloaded into the hopper of the worm feeder. For