

CHAPTER 22

THE PHARMACEUTICAL INDUSTRY

CHARACTERISTICS OF THE WASTE WATER

As in other branches of industry a wide variety of products are produced. It is difficult to make any generalization regarding effluents discharged from factories producing pharmaceuticals. The composition of the waste water varies considerably from plant to plant. There are factories producing only waste water from the washing of equipment and floors.

Relatively small quantities of waste water arise in the manufacture of most organic preparations, but larger amounts are formed during the synthesis of vitamin B₁ and from the manufacture of penicillin and other antibiotics.

Waste water from the manufacture of antibiotics can be divided into four groups (Brown, 1952).

1. Spent fermentation mash.
2. Water from washing floors and equipment.
3. Waste water containing acids, bases and solvents.
4. Condensate from condensers.

The first type of waste water has a very high BOD₅, 4000-13000 mg O₂/l.

The composition of the waste water type 2 is similar to that of group 1, but the BOD₅ is approximately 10 times smaller.

The group 3 waste water has a low BOD₅, but the pH must be adjusted. In most cases the organic solvents are recovered and cause no pollution problems.

The condensate 4 is only slightly polluted, with a low BOD₅ of 50-100 mg O₂/l.

A typical composition of the waste water from the production of penicillin after neutralization (from group 1), is shown in Table 22.1.

Many of the waste water problems in the pharmaceutical industry parallel those mentioned in connection with the organic chemicals industry, but there are some characteristic features which are typical of the pharmaceutical industry:

1. In the pharmaceutical industry there is a need for the manufacture of uncontaminated products. Thus the air in the production hall must often be cleaned, by use of a wet scrubber, for example. The water from the scrubber causes water pollution problems which must be solved.
2. The pharmaceutical industry requires solvents of high purity, and it is therefore often profitable to recover the used solvents. A distillation process is used for this recovery. If rather dilute solutions have to be treated, a three-step evaporation process precedes the final distillation.

TABLE 22.1

Composition of neutralized wastes from penicillin fermentation

Component	Concentration
BOD ₅ (mg O ₂ /l)	4200
Total solid (mg/l)	27000
Volatile solids (mg/l)	11000
Carbohydrates (mg/l)	900
Ammonium nitrogen (mg/l)	90
Nitrite nitrogen (mg/l)	30
Nitrate nitrogen (mg/l)	2

Methods of treatment

In many cases the treatment of pharmaceutical waste water consists of removing toxic compounds by precipitation or oxidation; metals, for example, can be removed by precipitation and cyanide by chlorination. Cyanide can also be removed by forming insoluble iron(III) and iron(II) cyanide. As already mentioned above, organic solvents are commonly recovered in the pharmaceutical industry.

After the removal of organic solvents or toxic compounds aerobic treatment or anaerobic digestion may be used (Eden et al., 1952). If the BOD₅ is high as, for example, in the production of antibiotics, anaerobic digestion may be preferred. Up to 95% removal of the BOD₅ by anaerobic digestion of waste water from the production of penicillin and streptomycin has been recorded (Jackson, 1960) and (Hilgart, 1950).

In some instances it might be profitable to recover proteins from the waste water (see chapter 28). In other cases incineration is the onliest answer to the waste water problem (Arbogast, 1949).

The following history serves to illustrate the waste water problems of the industry (Mohaurao, 1970).

A plant producing the following products also produces 500 m³ of waste water/24h:

1. Sulphurous compounds
2. Vitamins B₁ and B₂
3. Antipyrine and anti TB
4. Alcoholates
5. A series of intermediates

The waste water has the following composition:

pH 1.0

Dry matter (g/l)	86
Volatile materials (g/l)	50
Acidity (g calcium carbonate/l)	32
Chloride (g/l)	18.5
Sulphate (g/l)	28
KMnO ₄ number (g/l)	15.5
COD (g/l)	19.7
BOD ₅ (g/l)	13
Total nitrogen (g/l)	6.1

Chemical precipitation followed by a biological treatment process using activated sludge can be used in this case. Further examination will show that the water coming from production of the intermediates can with advantage be treated by precipitation with calcium hydroxide, which also neutralizes the rather acidic waste water.

The overflow from this treatment together with the waste water from the other processes can easily be treated biologically. It is of great importance for the efficiency of the biological treatment process that the culture is adapted to the special composition of this waste water.

REFERENCES

- Arbogast, C.H., 1949. Incineration of wastes from large pharmaceutical establishments. Eng. Bull., 33: 255.
- Brown, J.M. and Niedercorn, J.G., 1952. Antibiotics. Ind. Eng. Chem., 44: 468.
- Eden, G.E. and Lowden, G.F., 1952. Treatment of waste water from the manufacture of penicillin. Manuf. Chem., 23: 144.
- Hilgart, A.A., 1950. Design and operation of a treatment plant for penicillin and streptomycin wastes. Sew. Ind. Wastes, 22: 207.
- Jackson, S.J., 1960. The Treatment of Distillery and Antibiotic Wastes. In: Waste Treatment, Isaac, P.C.G (Editor), Oxford-London-New York-Paris.
- Mohaurao, G.J. et al., 1970. Waste treatment at a synthetic drug factory in India. J. Wat. Poll. Contr. Fed., 42: 1530.