

Description of the material flows

Refrigerator recycling plant

System *HECKERT*

General

During the processing of the refrigerators in our system, the useful and noxious materials contained in the refrigerators do not undergo any physical or chemical changes.

All processes taking place may be summarized under the general term "sorting" of the materials present in the composites.

The only exception is the condensation of the chlorofluorocarbons recovered from the refrigeration circuit and from the polyurethane foams. However, the only change occurring here is the thermally induced change in the state of aggregation from the gaseous to the liquid state.

This ensures that at no time in the entire process flow, starting from the supply of the refrigerators up to the point where useful and noxious materials are discharged from the system, by-products may be formed through chemical decomposition or oxidation (combustion).

Supply

Depending on the contractor in question, the following supply variants may be used:

- Delivery by container trucks or container trains
The refrigerators are unloaded directly in the shop. The vehicle can reverse into the shop and unload the containers immediately beside the processing area. The refrigerators are unloaded exclusively by hand in order to prevent the refrigeration circuits from becoming damaged. From the containers, the refrigerators are directly supplied for further processing.
- Delivery by trucks
The truck is also unloaded in the shop. A 70 m² steel trough (shaded in red in the drawing) serves as storage area. From this storage area, the refrigerators are supplied for further processing.

Disposal stage 1

The chlorofluorocarbon and the oil from the refrigeration circuit are removed simultaneously.

This technique constitutes the state of the art both in ecological and technical respect.

The system is characterized e.g. by:

- **the joint withdrawal of chlorofluorocarbon and refrigeration machine oil in one operation under hermetic conditions**

Thanks to the fact that the refrigerating machine oil is also withdrawn under hermetic conditions, the gas emitted from the compressed oil in the compressor is prevented from escaping. During the expansion (withdrawal) of the refrigerating machine oil, the chlorofluorocarbon, which has become dissolved in the oil during the operation of the refrigerator, is emitted in the form of gas bubbles. According to studies carried out by the "Ökofep" Institute in February 1988, the amount of gas emitted during the draining of the oil into open containers constitutes up to 30 % by weight of the total amount of R12 chlorofluorocarbon present in the refrigeration circuit.

The CFC-fluorocarbon-oil suction plant is an optimal contribution to the disposal in consideration of the environmental protection of discarded cooling appliances, the refrigeration cycles of which are containing the refrigerants R12, R22, R134A and R502. In case of the refrigerant R134a, the correspondingly approved refrigerant bottles are to be used.

With this suction plant the demands of the „Manual of disposal of cooling appliances“ of the German Environment authority are fulfilled (correct handling of the plant presupposed).

The suction plant consists of the following four main components:

1. Recovery Service Piercing Pliers
2. Evaporation Vessels
3. Suction Aggregate
4. Refrigerant Bottles

The plant is subdivided into the low pressure range and into the high pressure range:

Low pressure range

The lowest point of the refrigeration cycle is to be opened by means of recovery service piercing pliers, and the CFC-oil compound is completely sucked off by means of low pressure (approx. 200 - 600 mbar). The refrigerator oil is first retained in the 1st evaporation vessel. When the highest filling level is reached, the oil will be pumped over to the 2nd vessel, where it will be heated and atomized. The CFC will be evaporated and will be continuously sucked off. The result of this method is a

residual halogen content in the oil of less than 0,1 Vol. % allowing a recycling of the now non-contaminated waste oil and avoiding that it must be treated as toxic waste.

High pressure range

The CFC will be compressed, condensed and bottled. The bottles will be forwarded to a specialized company for recycling or disposal.

It is possible to effect the suction process on several old cooling appliances at a time

Sequence of operations in disposal stage 1

The refrigerators are placed one by one onto a conveyor belt and automatically adjusted to the required working level.

The throughput capacity of about 35 to 40 refrigerators/h has been optimized with respect to the next processing step.

Handling of the compressor

The compressor capsula, which has been drained in the aforesaid manner, is now demounted.

Then it is placed over a drip channel to allow any oil still remaining in the capsula to flow out. When it has been completely emptied after some time, the compressor is put into a small container with oil-tight bottom. Thereafter, the compressor fraction can be supplied for further processing to a scrap preparation plant.

Disposal stage 2

See "Description of process technique of PU recycling plant".

Utilization of useful and disposal of noxious materials

During the processing of refrigerators, the following useful materials and **noxious materials** are obtained and recycled:

Iron and non-ferrous metals, sorted

This fraction is made available by the company for reuse directly via scrap metal dealers.

Compressors, deoiled

Compressors are also recycled via scrap metal dealers.

Impact-tough butadiene-polystyrene in the form of granules (grain size about 15 mm and smaller) (see amendmend sheet)

Plastics processing companies use the polystyrene fraction for manufacturing new products. The material is transported by trucks. It is used in the manufacture of extrusion profiles or other end products (e.g. flower pots). A so-called utilization agreement concluded between the refrigerator disposal company and the material processing company ensures that there is an outlet channel for the material. The maximum storage capacity is about 20 t.

Degassed polyurethane in the form of powder (grain size < 0.2 mm, see amendmend sheet)

This material is processed into a high-quality water-repellent oil-binding.

Chlorofluorocarbons, mainly R12 and R11, and small quantities of R502 and R22 (waste material code number 55220)

The recovered chlorofluorocarbon can be supplied to manufacturers in need of this substance. Controlled incineration in a hazardous-waste incineration plant is also possible, but not envisaged at present. The chlorofluorocarbons are collected by local refrigeration wholesalers. Various recycling models for used chlorofluorocarbons have already been established in the market.

Used oil (chlorine content < 0.2 %, waste material code number 54102)

The oils recovered from the refrigeration circuit are filled into containers approved for materials of class A1, AII and B and stored in the shop on an impregnated floor (steel trough).

When the used oil is being collected, it is usually pumped from the storage containers into the collecting tank trucks. Thus, the refrigerator recycling company need not bother about the relevant legal regulations for the transport of hazardous goods. The used oil will usually be collected by local used-oil dealers.

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