Cooling Devices – Climate protection by professional disposal of end-of-life cooling devices

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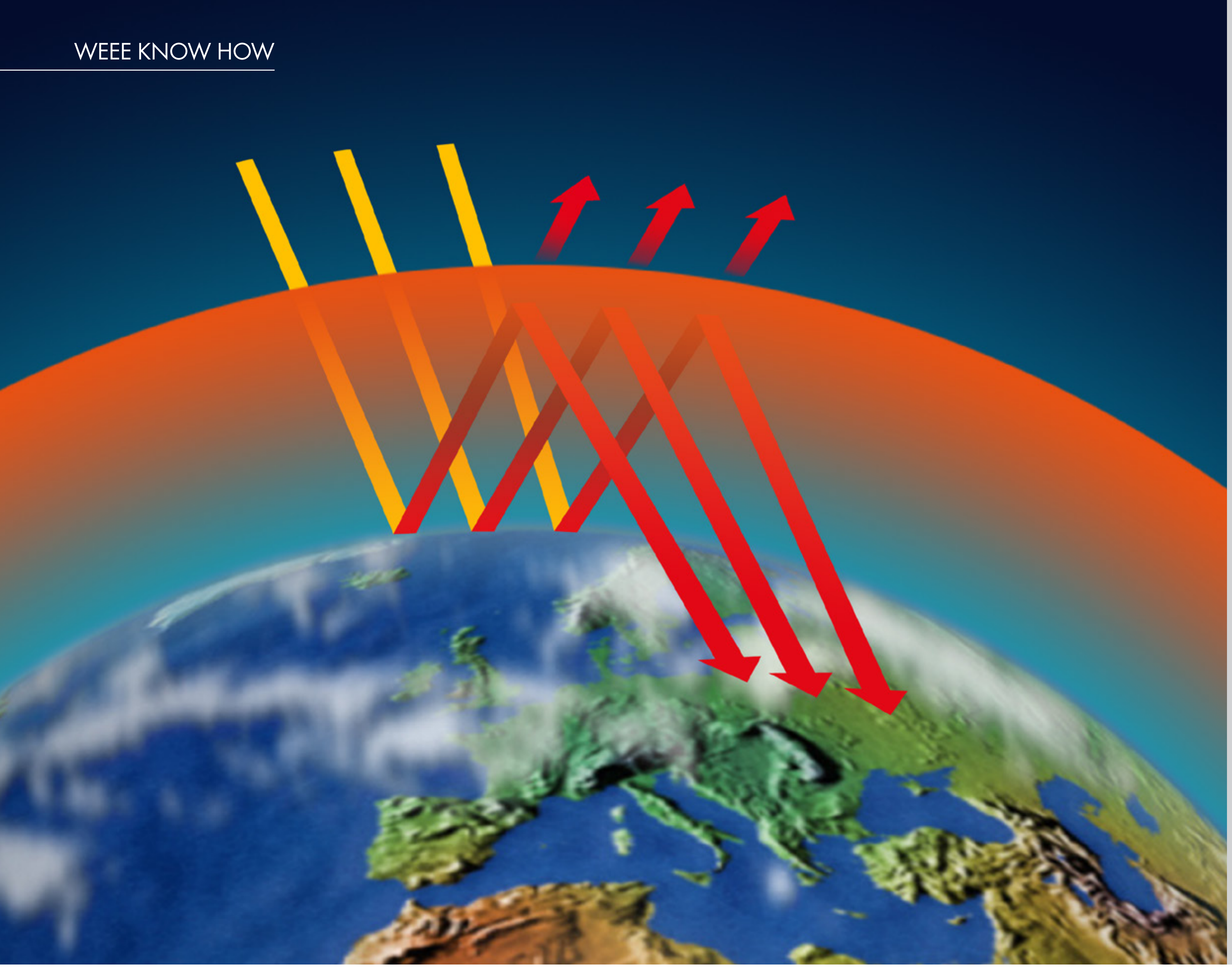
Referenzanlage

CLIMATE PROTECTION BY PROFESSIONAL DISPOSAL OF END-OF-LIFE COOLING DEVICES

The ozone layer is an important part of our ecosystem and protects us daily against strong, ultraviolet radiation of the sun. A chemical balance ensures that a relatively constant layer thickness remains. Due to their volatileness, chloro-fluorocarbons (VFC), released on earth, simply get into the earth´s atmosphere and reach the ozone layer at a height of about 20 km. The CFC blocks the ozone production there. The local reduction of the ozone layer is the result. During the 70s and 80s it was found out that mainly the VFC used in the industrial sector were responsible for this process and the reduction was started. 195 countries signed the Montreal Protocol in 1989 and resign to use these greenhouse gases mainly nowadays. Substitute materials which have similar physical characteristics but are much more environmentally-friendly are used rather now. However, it must be considered that VFC was used in many ways and, despite of prohibition of processing in Europe, VFC is still contained in many products from the past. There is still a huge amount of end-of-life cooling devices on the market which contain not only polyurethane foam in the insulation body but also cooling agents strongly contaminated with VFC.

This fact requires to dispose such end-of-life cooling devices properly and to separate CFC with suitable processes. The company URT Umwelt- und Recyclingtechnik GmbH has been constructing plants since 1995, which dismantle cooling devices in several work steps, separate them into single components and partially feed to the recycling process. It is very important that this process takes place in a closed room in order to avoid VFC gases escaping to the ambient air.



REDUCTION OF THE OZONE LAYER BY CFC

Ozone is distributed differently in the atmosphere and therefore plays different roles in the climate cycle. The gas in the stratosphere ensures that a large part of the ultraviolet radiation of the sun will be absorbed. Therefore, the ozone has a protective function: the UV-B-radiation can destroy cells of plants and animals and causes damage like skin cancer to humans. This means that the ozone is quite welcome here. However, the protective ozone layer in the stratosphere is mainly endangered by chlorofluorocarbons (VFC). The chlorine attacks the ozone molecules and destroys them: one chlorine atom can destroy up to 100,000 ozone molecules:

$Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$

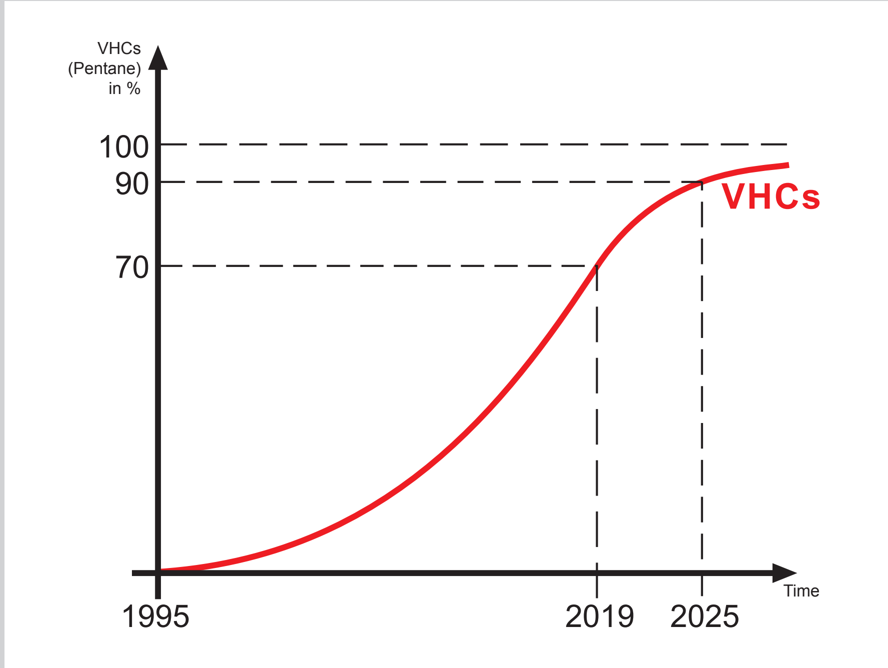
$ClO\bullet + O_3 \rightarrow Cl\bullet + 2\,O_2$

Chemical compound	Global Warming Potential	Ozone Depletion Potential
CO_2	1	–
F-11 (CCl_3F)	6 300	1
F-12 (CCl_2F_2)	10 200	0.82
H-FKW 134a (CF_3-CH_2-F)	3 300	0

CFC-SUBSTITUTE MATERIALS

The application of CFC-substitute materials presents a new challenge for cooling devices disposal plants

No more CFCs have been used for the production of cooling devices in Europe since 1995. Those cooling devices which have been produced with substitute materials meanwhile represent a considerable part. A common characteristic of all substitute materials for cooling agents and propellants is the flammability of these materials. For this reason, all treatment plants must be constructed as fire and explosion-proof. URT has already realized various concepts successfully. In case of new plants, it is quite reasonable to treat VHC (volatile hydro carbons) and VFC end-of-life cooling devices differently, as the operating costs can be reduced considerably if using different device treatment systems. The common treatment of end-of-life cooling devices results in the following context:



GLOBAL WARMING BY VFC

The following example demonstrates how to calculate the GWP (Global Warming Potential) of cooling devices. The cooling agent of this end-of-life cooling device is CFC R 12. CFC R 11 was used as propellant for the foaming:

Cooling agent R 12:

A compressor of one single end-of-life cooling device contains about 0.1 kg of CFC R 12.

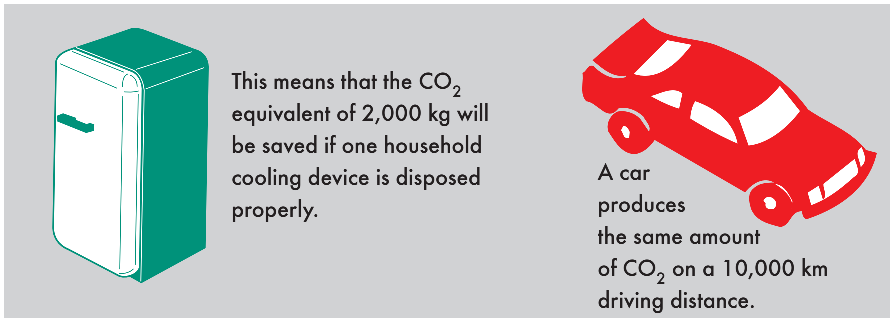
The GWP of CFC R 12 amounts to 10 200. A GWP of 1020 can be saved with proper disposal of one cooling device compressor.

Propellant R 11:

The polyurethane foam of one cooling device contains about 0.28 kg of CFC R 11.

The GWP of CFC R 11 amounts to 6 300.

A GWP of 1746 can be saved with proper disposal of the insulation foam.



The disassembly of cooling agent compressors takes place at the end of step I plant

DISPOSAL PLANT STEP I

The exhausting process of cooling machine oil and cooling agent takes place by using drilling heads or piercing pliers. The cooling agent (VHC and/or VFC) exhausted will be liquefied under pressure and will get to a collection tank. The plant is designed to dispose flammable (VHC) and non-flammable (VFC) cooling agents of any proportion. An integrated oil post-treatment (heating and surface expansion) system ensures that the required residual value of 0.2 % halogen will drop below in any case.

Sampling of cooling agent and cooling machine oil by means of drilling head at a compressor cooling device

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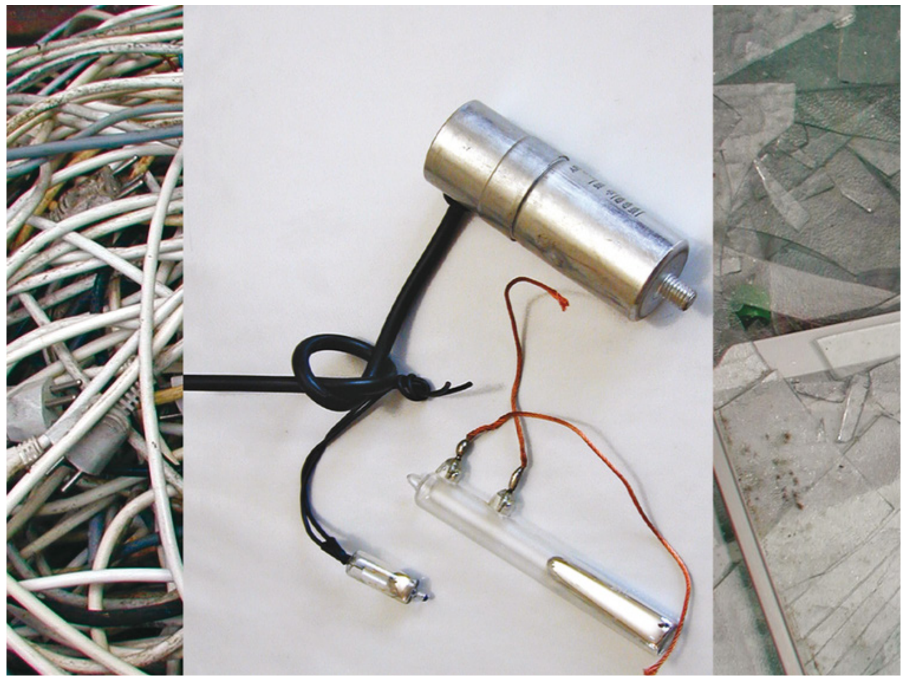
Step I plant with logistic line, piercing pliers and tilting table

PRE-DISMANTLING OF END-OF-LIFE COOLING DEVICES

A manual sampling of different fractions takes place before the actual treatment at the so-called step I and II can be started. Glass, external supply cables, food particles and especially two components with dangerous potential will be removed. These components with dangerous potential are mercurial tilt switches and condensers.



Mercury switch in glass capillaries and capacitor

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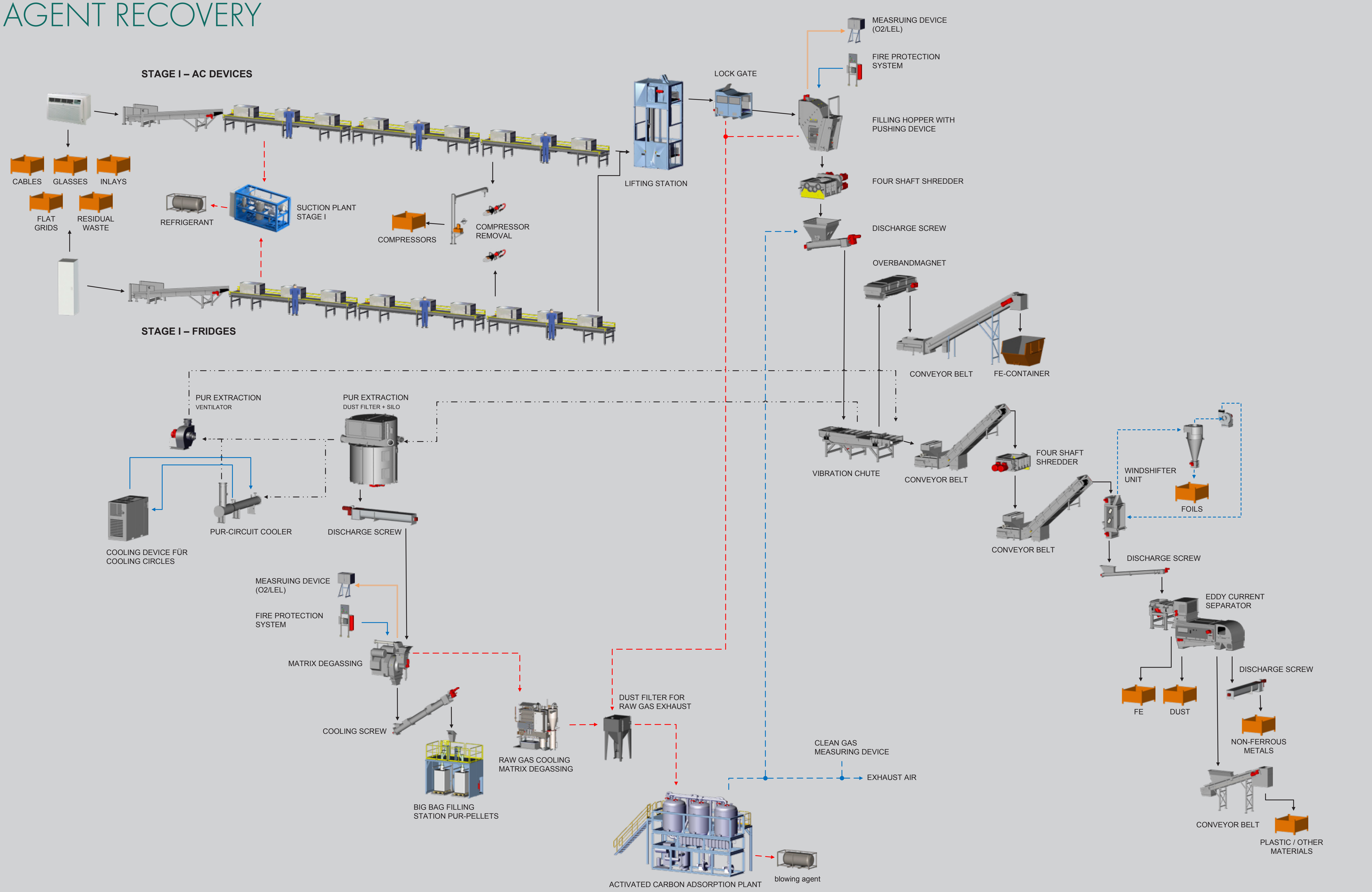
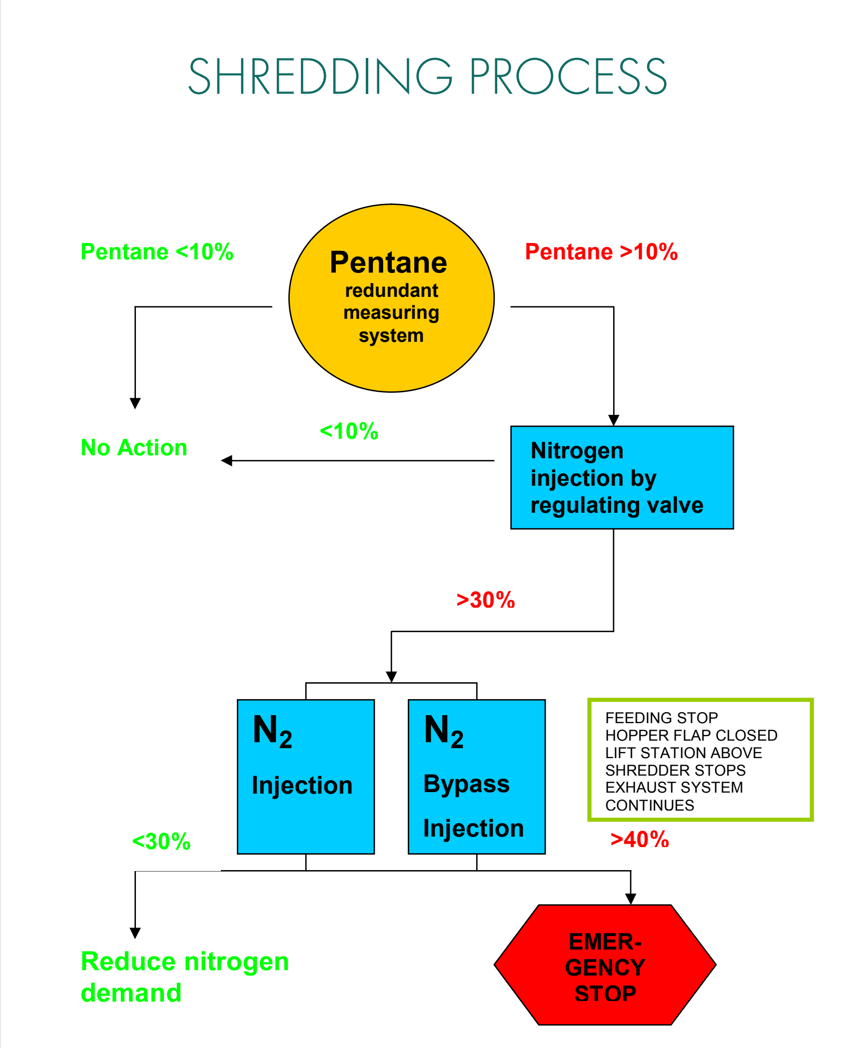
RECYCLING PLANT WITH BLOWING AGENT RECOVERY





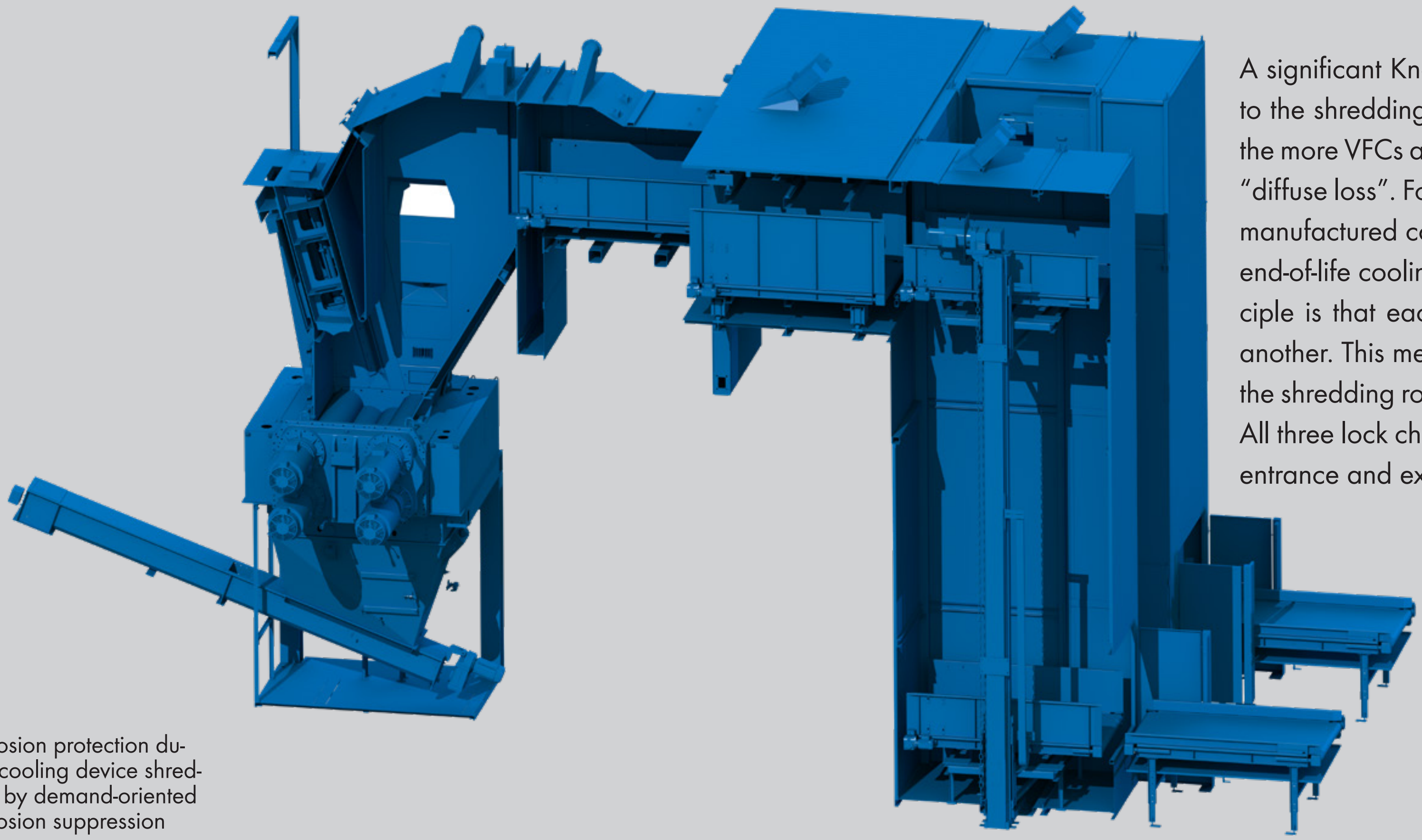
Explosion protection during cooling device shredding by demand-oriented explosion suppression

DISPOSAL PLANT STEP II

First of all, household devices are shredded in this treatment step. Afterwards, the solid material fractions like ferrous, aluminum and residual fraction containing mainly plastic parts are separated from each other. The polyurethane insulation foam is also separated during a density separation process. This insulation foam can be post-treated in the so-called matrix degassing to ensure a CFC-residual content of 0.2 %.

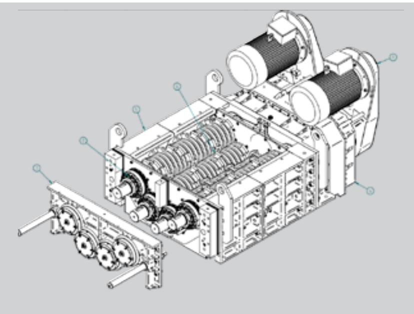
The propellant (VHC and VFC) released during the shredding and matrix degassing process is treated and liquefied in a process gas treatment procedure. Filling into storage and transport tanks takes place subsequently. For the process gas treatment, URT offers active carbon adsorption plants or plants for cryogenic condensation. The propellant condensate will be destroyed externally afterwards.

LOCK SYSTEM TO MINIMIZE EMISSIONS



A significant Know-How is the feeding of end-of-life devices to the shredding units. The more open this feeding is made, the more VFCs and VHCs will emit uncontrolled. This is called "diffuse loss". For more than 15 years, URT has planned and manufactured combined feeding and lock devices to feed end-of-life cooling devices into step II plant parts. Basic principle is that each cooling device must pass one lock after another. This means that there is no plant condition in which the shredding room is connected to the building atmosphere. All three lock chambers are equipped with lock doors on the entrance and exit.

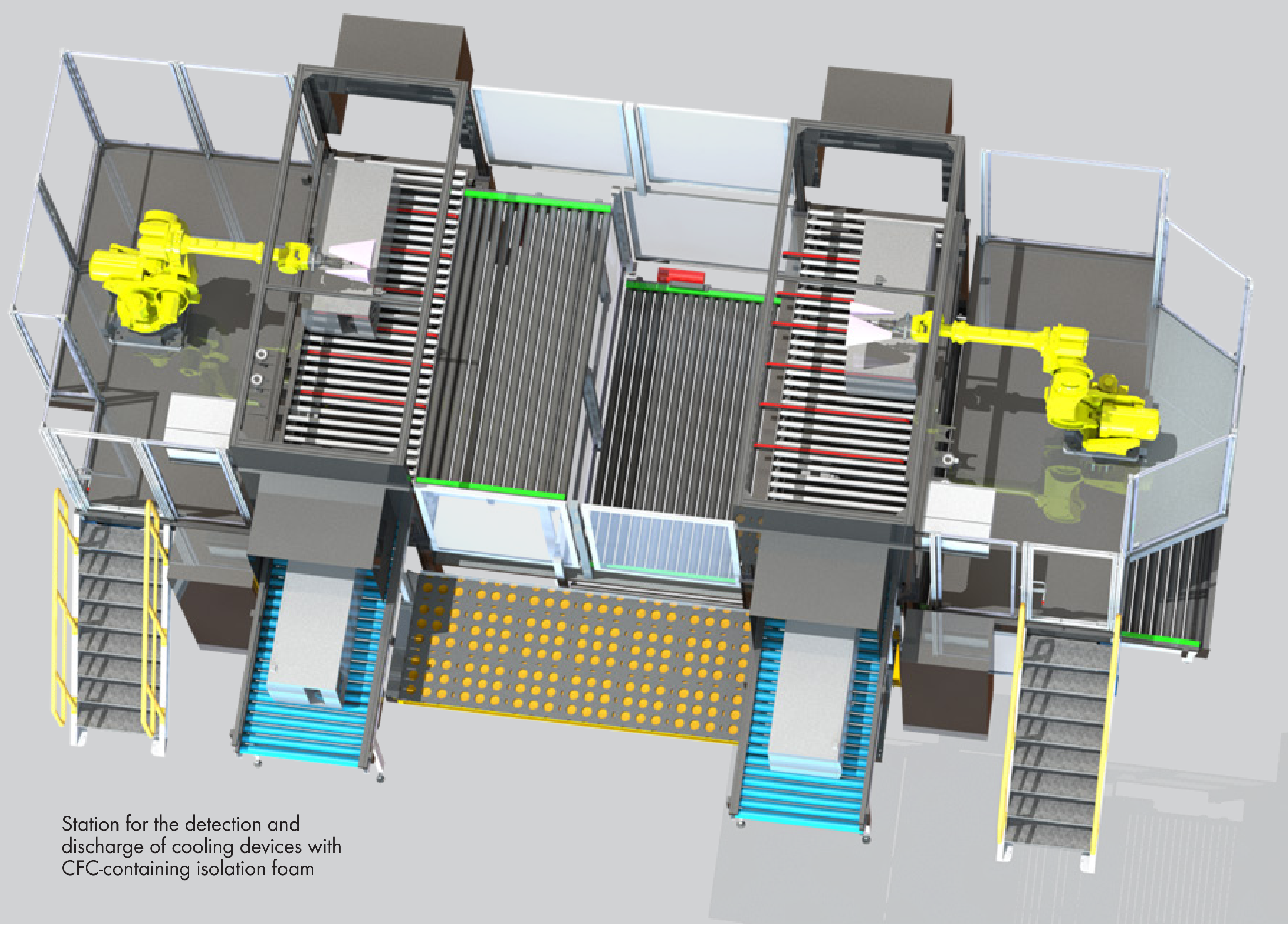
FOUR SHAFT ROTOR SHEAR



UNTHA has manufactured four-shaft rotary shears for over 35 years now. We work with one step or two steps when it comes to cooling device shredding. Both the pre-shredder and the post-shredder are four-shaft rotary shears. Both shredders are equipped with a perforated sieve. This perforated sieve serves to dimension the output fraction and is – referring to cooling device shredding – required to clean the PUR sticking on metal and plastic parts.

Advantages of these rotary shears are:

- Robustness of cutting tools, gear and casing parts
- Minimize slow rotation speed (about 25 min^{-1}), dust formation and risk of explosion
- Knife change without disassembly of shafts, gears or motors



Station for the detection and
discharge of cooling devices with
CFC-containing isolation foam

VHC TREATMENT – SELECTIVE –

The share of halogen-free refrigerants and blowing agents is increasing in the disposal of cooling devices.

Change of device composition

Since 1995, no refrigerators have been produced in Europe with halogen-containing refrigerants and blowing agents (CFCs). Accordingly, the share of alternative refrigerants and blowing agents is rapidly increasing during disposal. In most German waste disposal plants, the share of halogen-free refrigerators has already increased to more than 50%. In southern European countries this share is already over 70%. Within the next 5 years, this share can rise to 90%. Conversely it is expected that 5-10% of halogenated (CFC) end-of-life refrigerators have to be disposed during many years to come.

Selective treatment of end-of-life refrigerators

Especially in the field of corpus treatment (step II), it makes sense to think about new plant concepts, since the treatment of end-of-life refrigerators with halogen-free blowing agents will be more expensive in conventional plants than the treatment of the halogen-containing refrigerators. This is due to the combustibility of the alternative, halogen-free blowing agents (pentanes).

Analytical detection of blowing agents in polyurethane foam

URT Umwelt- und Recyclingtechnik GmbH has been working on concepts for reducing operating costs for years. Core technology is the unequivocal selection between halogen-free and halogen-containing insulation foams. This is the basis for a later selective treatment of the refrigerators. For this purpose, openings are made on the corpus and on each door of the respective end-of-life refrigerator. Gas samples are taken, which are subsequently analyzed automatically.

Direct burning of halogen-free blowing agents

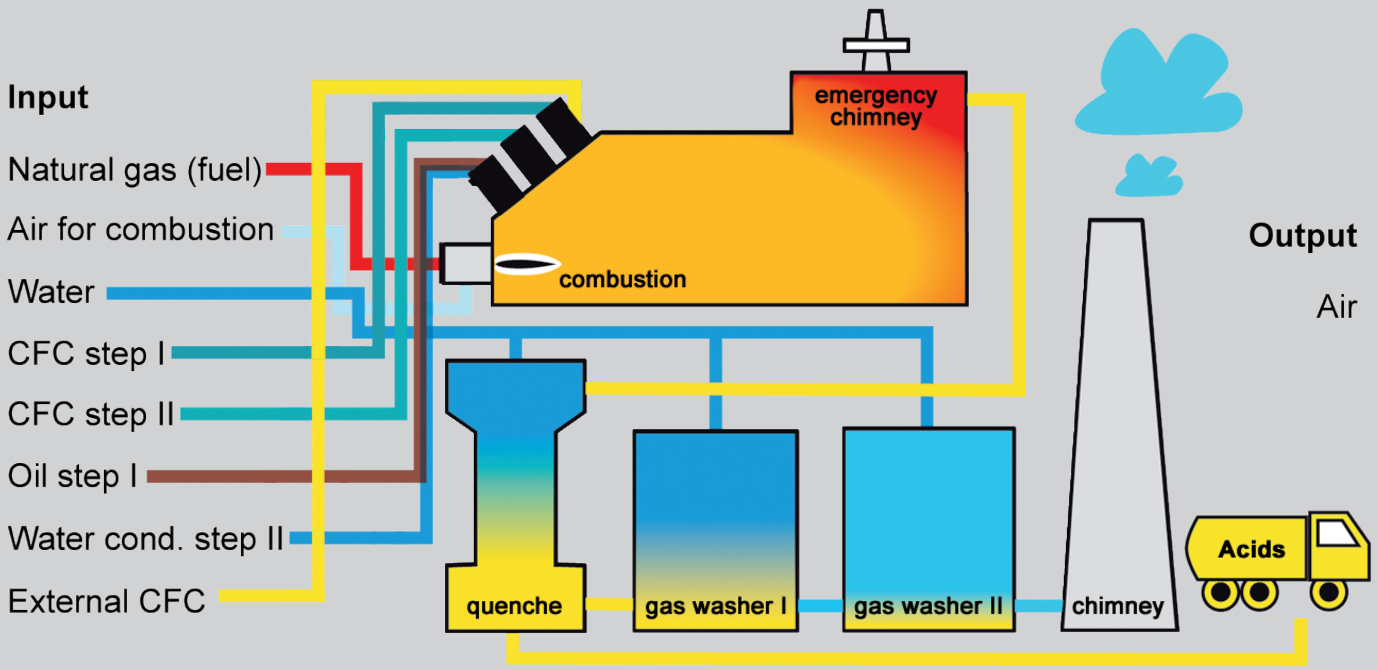
Usually, blowing agents are recovered and liquefied at refrigerator disposal plants. The CENELEC standard was the first regulation that described a step III treatment in EN 50574. This is the direct burning of blowing agents from the polyurethane foam. Direct combustion of halogen-free blowing agents is significantly more simple than the combustion of halogen-containing blowing agents from polyurethane foams. Due to high suction quantities for detection of blowing agents the explosion limit can fall down significantly by dilution. The use of nitrogen for explosion suppression is no longer necessary. The high exhaust volumes reduce diffuse losses of blowing agents. Emission regulations at the plants and in the exhaust air can be definitely underrun.

Reference plant in Germany

A cooling device recycling plant which is operated like this plant concept has been installed at the company ALBA Electronics Recycling GmbH already in the first quarter of 2017.

An existing plant is continuing furthermore the disposal of CFC-containing refrigerators. The new plant of the company URT Umwelt- und Recyclingtechnik GmbH is intended for halogen-free end-of-life refrigerators.

GAS WASHER EXHAUST AIR CLEANING SYSTEM AND PRODUCTION OF DILUTE ACID

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DISPOSAL PLANT STEP III FOR VHC AND VFC

URT offers a patented system for direct conversion of climate-damaging gases in non-climate-damaging gases. During the so-called "cracking process" the gaseous CFCs and HCFCs will be dismantled into their molecules at a temperature of about 1200 °C. Aim is to produce watery hydrofluoric and hydrochloric acid from the chlorine and flour molecules. These acids are not harmful for the climate anymore and can be used in the chemical industry. An appropriate measuring technology continuously monitors the destruction of CFCs.

Advantages by using the direct combustion of CFCs

- No disposal costs for VFCs step I and step II
- Complies with the requirements of EN 50625
- No disposal costs for compressor machine oil
- No consumption of liquid nitrogen
- Less energy consumption
- VHCs serve as fuel
- External VFCs can be destroyed
- CO_2-certificates can be generated under certain conditions

R11	$CFCl_3 + 2H_2O$	→	$CO_2+3HCl+HF$
R12	$CF_2Cl_2 + 2H_2O$	→	$CO_2+2HCl+2HF$
R134a	$C_2H_2F_4 + 2H_2O + 3/2O_2$	→	$2CO_2+4HF+H_2O$
R141b	$C_2H_3FCl_2 + 2O_2$	→	$2CO_2+ 2HCl+HF$
Pentan	$C_5H_{12}+8O_2$	→	$5CO_2 +6H_2O$

Chemical reactions step III

Step III plant by URT in Brazil

One-stop planning, production, delivery and service

Factory Karlstadt, Germany

Shop Assembly

After-Sales-Service

Design Department

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