



Positively Innovative

Meeting with DGPR, French Environment Ministry

Nov 10, 2023

Daikin Industries, Ltd.

- I. Introduction to Daikin
- II. Daikin Chemical France's PFHxA phase out plan
- III. PFHxA restriction proposal
- IV. PFAS restriction proposal
- v. Other topics

I. Introduction to Daikin

Daikin Industries, Ltd headquartered in Japan, is one of the world’s leading producers of fluorochemicals as well as air conditioning and refrigeration equipment

European presence



Daikin Chemical Europe GmbH is a German subsidiary of the Chemicals Division of Daikin Industries, Ltd, headquartered in Osaka, Japan.

Daikin Chemical Europe GmbH supervises four manufacturing facilities in the EU: Daikin Chemical France S.A.S., Daikin Refrigerants Frankfurt GmbH, Daikin Compounding Italy S.p.A (previously called Heroflon S.p.A) as well as Daikin Chemical Europe Innovation Center in Dortmund.

Daikin Industries, Ltd. produces and supplies air-conditioning, heat-pump and refrigeration equipment in Europe, under Daikin Europe N.V./S.A, Daikin Applied Europe S.p.A., and Zanotti S.p.A.

- Number of employees in 2023 (DCE): 381
- Turnover FY20: 218.5m euro



Daikin's main product offering* in relation to the manufacturing, placing on the market, and use of PFAS:

Fluoropolymers



This includes: fluoroplastics and fluoroelastomers, notably **FKM that is produced in France, at Daikin's site in Pierre Bénite.**

Examples of main uses: Automotive including electric vehicles; semiconductors; hydrogen; and other technologies supporting the green and digital transition.

C6 side-chain polymers



Examples of main uses:
woven and non-woven textiles for medical; automotive; and professional apparel.

F-gases



Example of main uses:
Stationary air conditioning; refrigeration; applied unit (chillers); mobile air conditioning; and medical usage.

Means of transport



In **automotive applications**, FKM is used in various engine components such as **fuel and turbo charger hoses, piston coatings, gear box and transmission seals, shock absorbers, particle filter hoses, seals for EV motors, fuel cell coatings** etc.

For shipping and aircraft, FKM is used for **stern tube seals, fuel hoses and gaskets, seals for rotating shafts**, etc.

FKM is also used in **oil caps for bullet train lines, venting seals for liquid seal transformers** ect.

Oil & Gas and Hydrogen



Used to ensure **drilling equipment is safe and efficient**. With **high drilling depths** come higher temperatures, exceeding 200 degrees C.

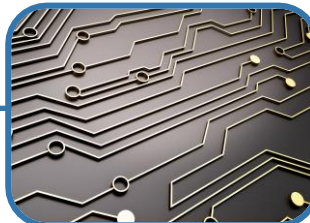
For hydrogen, FKM is used as **separators of fuel cells** in electrolyzers, **sealing** material for the compression process, **coating** in the cells.

Industrial machinery



Used in O-rings and seals as **sealants against oil in industrial machinery and robots** i.e. reduction drives, in a wide range of industrial machinery, especially in sectors where there is increasing automation, including for vehicle manufacturing.

Electronics, including semiconductors



Used to provide **heat/fuel/oil resistance in wires and cables** (i.e. LAN/telecommunication, automotive, industrial machineries)

Oil and water resistant sealings and o-rings (i.e. copper-clad laminate in automotive/telecommunication millimeter wave radar).

Heat resistance for next generation semiconductor chips.

II. Daikin Chemical France's PFHxA phase out plan

- Full subsidiary of DAIKIN CHEMICAL Europe
 - Located in Pierre-Benite industrial platform (69)
 - Certifications ISO 9001, 14001, 45001
 - Production
 - **FKM Base Polymers**
 - **FKM Precompounds**
 - **Polymer Processing Aids (PPA)** - mainly used for additives to other polymers such as PE, PP, PC, PA.
- Currently produced with PFHxA
- Direct employees: approx. **70** people
 - **82%** of FKM placed on the EU market by Daikin is produced at DCF
 - Daikin represents about **25%** of the EU FKM market



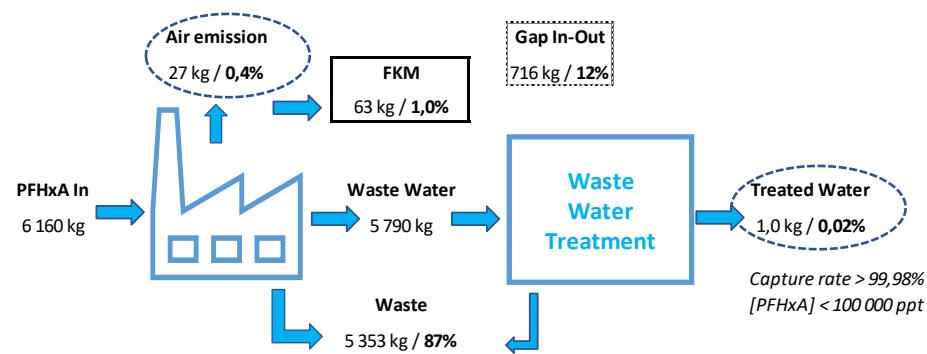
PFHxA emissions capture – state of play (1/2)

Summary : During FY22, DCF conducted surveys and deep analysis on PFAS emissions from the plant (water, air, and waste) and its surrounding areas (soils, subsoils, vegetables, and air), mainly based on request from decrees from French Environmental Authorities (DREAL). The authorities **recognized DCF's high performance in wastewater treatment to capture PFHxA [see 1.]**, **PFHxA mass balance at factory is available [see 2.]**, and **PFAS used by DCF did not exceed the thresholds during monitoring within a 1 km radius around the plant [see 3.]**.. In FY23, DCF will continue to collaborate with DREAL to reduce emissions from water to comply with future regulations. Additionally, DCF will work with DIL to **reduce emissions from air as required by authorities** and prepare to transition to **an alternative technology to replace PFHxA**.

1. Wastewater treatment result 2022 - 2023

		2022												
Month	-	01-22	02-22	03-22	04-22	05-22	06-22	07-22	08-22	09-22	10-22	11-22	12-22	Total
PFHxA emission to water	(g)	Internal analysis (LQ = 70 ppb)					166	18	37	172	240	6	2	640
Capture rate	(%)	Non detected					99,95	> 99,99	99,99	99,96	99,95	> 99,99	> 99,99	99,98
		2023												
Month	-	01-23	02-23	03-23	04-23	05-23	06-23	07-23	08-23	09-23	10-23	11-23	12-23	Total
PFHxA emission to water	(g)	240	379	14	7	212	28	36	154	4				1 075
Capture rate	(%)	99,95	99,91	99,99	> 99,99	99,97	99,99	99,99	99,97	> 99,99				99,97

2. On-site measurement / PFHxA material balance



3. Out of site measurement in the environment

As requested by decree, in 2022 DCF performed PFAS analyses on soils, subsoils, ambient air, vegetables 1km around the plant, with around 18 sampling points.

Results pointed out:

- Air ⇒ no exceeding of threshold values
- Soils, subsoils ⇒ exceeding of thresholds for **PFNoA (C9)**, **PFUnA (C11)**
- Vegetables ⇒ exceeding of thresholds for **PFNoA (C9)** in case of carrots



PFHxA emissions capture – state of play (2/2)

❖ 4- Next steps

❖ Additional requirements from Authorities

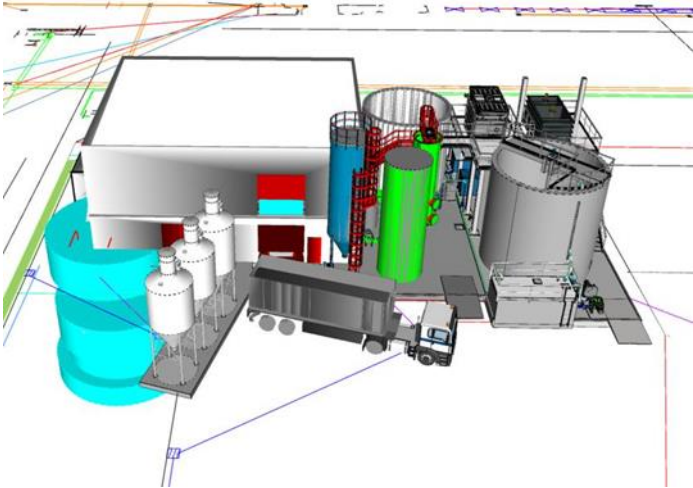
- Additional measurement in the water « Arrêté Ministériel PFAS Juin 2023 » [2023-2024]
- Input of data in the questionnaire from DREAL [2023]
- Study of PFHxA dispersion around the plant [2023 end]
- Additional measures in the environment (air, soils, subsoils and vegetables) [2023 end]
- Proposal of Toxicological Reference Value and exposure scenarios to French Environmental Authorities [2023 end]
- Realization of studies « Evaluation de l'état des milieux IEM » & « Evaluation Quantitative des Risques Sanitaires EQRS » [2024]

❖ Further initiatives to reduce emissions to water and to air

- Reduction of emission to the water: new project to improve current waste water treatment to achieve PFHxA capture < 100 ppt [2025]
- Reduction of emission to the air: new project to reduce PFHxA and HFP emissions by using activated carbon belts on channelled piping from the plant [2024 mid]

❖ Transition to an alternative technology to replace PFHxA [Q1 2026]

Future waste water plant



Current waste water plant



RO membranes



New decantor



❖ **Tentative timeline for transition to PFHxA alternative**

- **Q1 2024:** Trial at DCF
- **Q1 2024:** Sample to be supplied to customers for their evaluation
- **Q4 2025:** Installation of equipment for commercial production
- **Q1 2026:** Commercial production starts

❖ **Hazard information on hydrocarbon alternative as polymerisation aid**

Product	Hazard information (REACH registered, high tonnage band)
Most promising candidate	H315: causes skin irritation H318: causes serious eye damage H335: may cause respiratory irritation

PFHxA Restriction proposal

Daikin is generally in support of the European Commission proposal:

- **Does not include FKM**
- **Targets well-defined categories of products intended for the general public**, where substitution is generally possible and does not affect essential uses.

Implications for the PFAS restriction proposal

- **Responsible manufacturing of fluoropolymers**, incl. FKM, proposed to be addressed under the PFAS restriction proposal
- Need to cover **derogations for the use of C6 short-chain fluorinated polymers in professional and industrial applications** where alternatives are not available, including PPE, technical textiles used in transport, filtration and medical applications, as well as semiconductors.

All PFAS Restriction proposal

In September 2023, Fluoropolymer manufacturers have committed to a **Responsible Manufacturing Programme for European manufacturing sites:**

Key-elements of the programme are as follows:

1. The manufacturers have committed to the highest standards worldwide for manufacturing
2. The manufacturers will establish a platform to promote and adopt state-of the art technologies to **minimize all non-polymeric PFAS emissions** in manufacturing.
The platform should be active from Q1 2024 onwards
3. Minimize emissions of **non-polymeric PFAS residues from polymerization aids** to emission factors (EF) of
 - 0.009% to air and 0,001% to water by 2024
 - 0,003% to air and 0,0006% to water by 2030EF = mt of PFAS emitted per year / mt of PFAS produced or processed per year.
The formula is given in the restriction dossier by the 5 competent authorities in Annex B, p. 227
4. Inform downstream users on their safe handling

Competing companies are going to share innovation power to bring solutions to challenges that no one single company can solve by their own.

DCF already complies with these targets. After the PFHxA phase out, DCF will comply with para 5a of the restriction proposal.

REACH restriction

Fluoropolymers: Responsible manufacturing	General comments on scope
Daikin shall comply with paragraph 5a of the proposal for FKM production Daikin supports site management plans (also for DUs) as set out in paragraph 8 → Way to collect further information on uses and emission control, and where justified, have further RMMs → Suggestion to report information to national authorities (or ECHA)	ECHA's Enforcement Forum: "challenging to enforce" Daikin supports a differentiated, more targeted approach based on the different risk profiles of PFAS incl. their uses, in line with Art. 68.1 → Focus on consumer applications + responsible manufacturing requirements for fluoropolymers → More detailed risk and socio-eco assessment needed for most industrial and professional applications, including R&D

Outside REACH

R&D, Design
Support R&D and Innovation in emission control technologies, design for disassembly, recycling technologies
Improve waste handling
- Enforce already existing collection / EPR obligations (e.g. F-gases from ELV, WEEE) - Expand incineration/recycling capacities

In total, Daikin submitted derogation requests for a variety of critical applications, incl. critical R&D applications due to unique innovation potential of PFAS in particular to support decarbonisation.

Fluoropolymers	Time requested
Derogation request for FKM critical applications + responsible manufacturing at DCF – supported by hundreds of contributions from DUs to the public consultation	Unlimited
FKM (fluoroelastomer) bladder material for tyre vulcanization process	12 years
FKM (fluoroelastomer) repair/protection materials for civil infrastructure	12 years
Fluoropolymer Coatings of magnet wire for high voltage electric motors	unlimited
Anti-reflective(AR) fluoropolymer coatings of optical sensors and parts	unlimited
PFPA -based coatings in optical lenses, sensors, and optical sensor coating parts and displays	unlimited
PFAS Materials for Advanced Electrolyte Applications for Lithium-ion Batteries	unlimited
Verification of Non-PFAS Materials as Cathode Binder for Lithium-ion Battery	unlimited
Suitability Verification of Materials for Gasket in Lithium-ion Battery	unlimited
FEP (fluorinated ethylene propylene) as insulation material for single pair ethernet	Unlimited or 12 years
PTFE-filters for air filtration	Unlimited
Fluoropolymer-based architectural coatings	unlimited

F-gases	Time requested
(F-gas) HFC-227ea pharma propellant in metered-dose inhalers	12 years
(F-gas) maintenance and refilling of RACHP equipment without alternatives	Unlimited
Refrigerant R-474A for electric vehicles	Unlimited
Other	Time requested
PFOB in manufacturing of inhaled respiratory medicines	2036 – as defined in POP Regulation
Industrial and professional applications of C6 SFPs	unlimited
product and process orientated research and development (PPORD)	unlimited
Support of derogation proposal 5(t) for calibration and analytical use	unlimited

Current Electric Vehicles Refrigerants

→ Range anxiety, Bad climatic control

R-1234yf (HFO refrigerant)

- 👍 Good performance (cabin comfort) in summer
- 👎 Low performance (cabin comfort) in winter

R-744 (CO₂)

- 👍 Good performance (cabin comfort) in summer
- 👎 Low performance (cabin comfort) and efficiency (driving range) in winter
- 👎 Higher vehicle weight

Future Electric Vehicles Refrigerants

→ Improved driving range and uncompromising thermal management

HFO-blend R-474A (R-1234yf/R-1132(E))

- 👍 High performance (cabin comfort) in summer
- 👍 Good performance (cabin comfort) in winter
- 👍 High efficiency (driving range) in summer and winter

R-744 (CO₂)

- 👍 Good performance (cabin comfort) in winter
- 👎 Low performance (cabin comfort)/efficiency (driving range) in summer
- 👎 Higher vehicle weight

R-290 (Propane)

- 👎 Flammability and safety

PFAS restriction proposal bans R-1234yf and all related refrigerant technologies

Advanced R-744 (CO₂) experience of German OEMs leads to **competitive demerit for French car manufacturers**

Technical disadvantage of R-744 (CO₂) leads to **competitive demerit for European car manufacturers** on global market

Fluoropolymers (notably PFA) as insulation material of magnet wires for high voltage motors (starting from 800-1000 V), in line with the growing electrification/decarbonisation trend

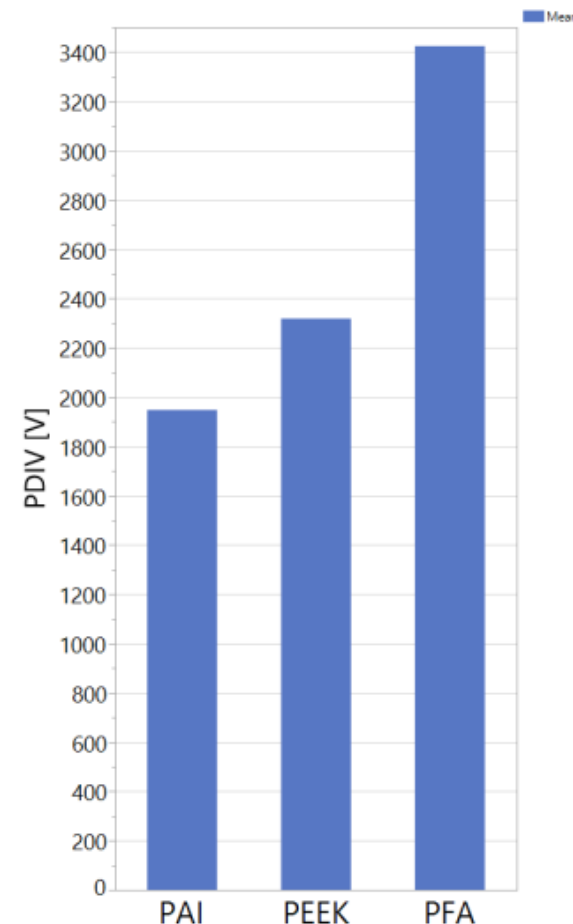
In collaboration with two European partners: Additive Drives GmbH, Dresden, Germany, Tre TAU Engineering, Turin, Italy

Key applications: electric cars, buses, trucks, aerospace, industry applications, robots, fans and compressors.

- For e-trucks: starting point will be 1000 V

In case of ban, battery voltage will be stuck at 800 V. This will be detrimental to electrification for the following reasons:

- No decrease of charging time of batteries
- Reduced driving distance due to lower efficiency of the motor
- Higher e-motor sizes resulting in increase of material consumption, specifically aluminum, steel and copper
- Reduced lifetime prompting earlier replacement
- Issue in terms of availability of alternative materials to meet growing demand



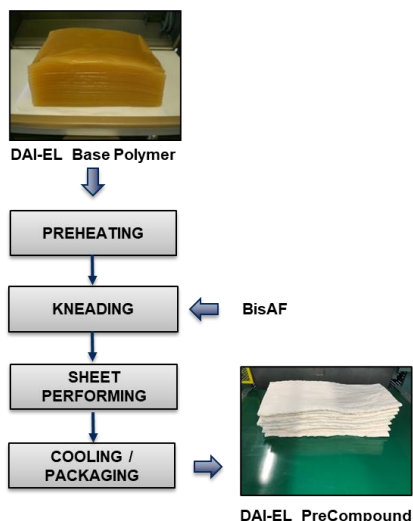
PDIV corresponds to resistance to electrical sparks that occur even more frequently with e-motors. PDIV depends on the motor insulation. What counts is the difference between the materials.

PDIV results in higher efficiency, downsizing, longer life motors.

Other initiatives

Summary : Daikin has decided in 2020 to relocate precompound production from The Netherlands to France (Pierre-Benite), where FKM base polymer is produced. Accordingly , Daikin has prepared a folder “Porter à connaissance” to the Prefecture in 2021 for this new activity, which has been assessed as “non substantial” modification of Daikin’s environmental permit by DREAL in 2022. **This new FKM Precompound factory has been built with Best Available Technologies equipment’s for emission in the air.** Additional prefectoral decree will be delivered to Daikin with additional requirements. As Bisphenol AF is classified CMR category 1B and PFAS, new requirement is including the **studies for an alternative to Bisphenol AF within 36 months.**

❖ Simplified process flow chart



❖ New factory at Pierre-Benite



❖ Summary of the activity

Target of this new activity is to mix some additives into the FKM Base Polymer. There is no chemical reaction during this process. Capacity of the new factory will be 9 t/day and 1 500 t/y. Main risks coming from this new activity are coming from products themselves, including reprotoxicity in case of Bisphenol AF (CMR cat.1, H360).

❖ Contents of complementary prefectoral decree

- Update of « ICPE » categories
- Update of threshold for VOC emission taking into account the usage of acetone for cleaning
- Regular analysis on air emission (2 months after start-up and every 6 months)
- Regular analysis on water emissions every months during 6 months
- Thresholds on air emission (VLE) based on the lowest limit of BREF WGC at 1 mg/m3
- Study for Bisphenol AF substitution within 36 months

❖ Focus on requirement to substitute Bisphenol AF

12 – 2 – Substitution des substances cancérogènes et PFAS

L'exploitant propose un plan de substitution dans un délai maximum de 36 mois à compter de la notification du présent arrêté des substances classées CMR toxiques pour la reproduction de catégorie 1B qui appartiennent à la famille des PFAS. A défaut, Daikin devra démontrer dans le même délai l'impossibilité technico-économique de cette substitution et l'absence d'impact sanitaire et dans l'environnement de ces substances compte tenu de l'état des connaissances à la date de transmission. L'exploitant remet un rapport d'étape sous 18 mois à compter de la notification du présent arrêté.

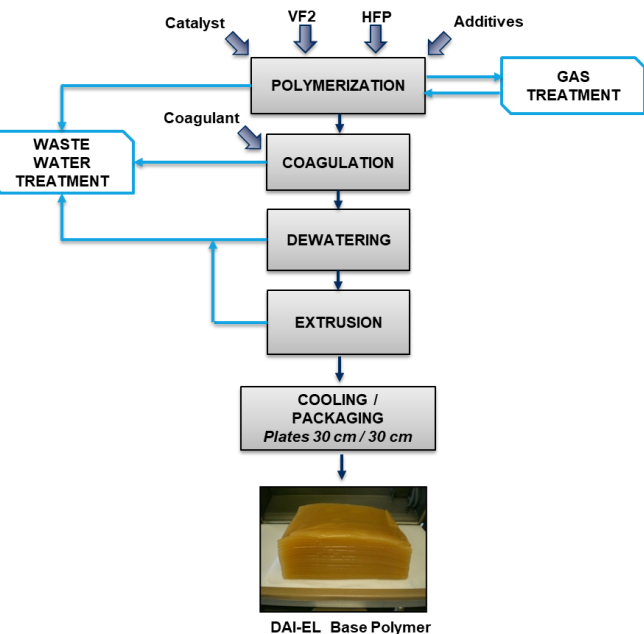
❖ Concerns:

- No visibility on substitution timeline despite continuous efforts to find a suitable alternative
- Not in line with approach envisaged under recently withdrawn REACH restriction proposal on bisphenols that clearly intended to derogate FKM containing residual BPAF
- Risk of distorted competition compared with other precompound FKM manufacturers in the EU, if a ban of BPAF was introduced for DCF.

Hexafluoropropen (HFP)

Summary : in 2018, Daikin informed environmental policy (DREAL) of **modification of hazardous statement for hexafluoropropen (HFP)**, which is one of the 2 main raw material utilized to produce its fluoroelastomer base polymer. New self classification proposed by Daikin was now carcinogenic catégorie 2, **H351 “suspected of causing cancer”**. As a result, **Daikin received in 2020 a formal notice from DREAL to comply before end of 2020** with threshold of 20 mg/Nm3 for its channelled emission, according to decree from February 1998. Daikin performed several actions from that time and finally made request in 2023 to **get exemption from the threshold value of 20 mg/Nm3** based on technical-economical study and health impact assessment around the factory. This request has finally been rejected in July 2023. **Daikin proposed an action plan in Oct.2023 to be compliant with regulation by July 2024.**

❖ Simplified process flow chart



❖ Summary of action plan proposed to DREAL on Oct.10th, 2023

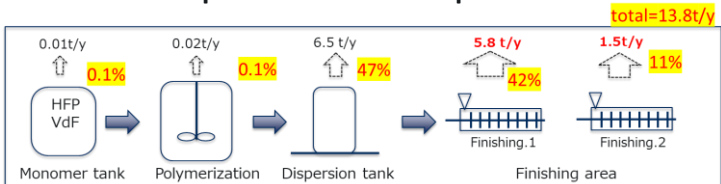
First stage by July 2024

- ➔ Reduction of HFP channelled emission by more than 90% (less than 800 kg/y) using activated carbon process by July 2024 to comply with regulation of Feb.1998
- ➔ DAIKIN will make best effort to build and start activated carbon process from May 2024 and then reduce HFP channelled emission by 60% or more by connecting on this new facilities at least the 2 mains contributors [dispersion tanks (ar. 6,5 t/y), vacuum pump F1 (ar. 4,1 t/y)]
- ➔ Cost stage 1 : Capex: 540 k€ +/- 40% // Opex: 2-4 M€ / year

Second stage by 2026

- ➔ Introduction of new technologies to recover HFP from dispersion and re-use HFP at Polymerization stage
- ➔ Introduction of new technologies instead of granulated activated carbon to comply with future regulations, reduce high operating cost, and reduce amount of waste coming from granulated activated carbon.
- ➔ Cost stage 2: under consideration

❖ Simplified HFP emission points

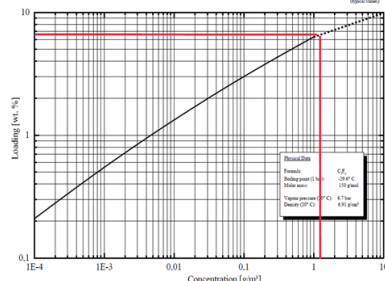


[HFP absorption capacity graph]

Carbon have the ability to absorb HFP



Adsorption Isotherm of hexafluoropropylene from Air at 20° C
Activated Carbon : Desorex K 43



Thank you