

NEWMOA PFAS Technical Workshop – Activated Carbon



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Agenda

- Who We Are
- Benefits of Using GAC for PFAS removal
- GAC Product Differentiators
- Importance of Testing in PFAS Applications
- Rapid Small Scale Column Testing (RSSCT) Results
 - PFOA/PFOS Application
 - Short Chain PFAS (PFBA, PFHxA, PFBS, PFOA, PFHxS, PFOS)



Corporate Profile

Who Is Calgon Carbon Corporation

- World's largest producer of Granular Activated Carbon (GAC)
- Solves customer purification and separation problems with an array of technologies
- Water treatment is core competency with a diverse product portfolio

\$514 million

2016 net sales

75 years

experience

1,400+ employees



25 offices

sales and service

20 facilities

Manufacturing, reactivation,
equipment

240 patents

Benefits of Using GAC for PFAS Removal



Leading technology for removal of PFCs from drinking water and groundwater



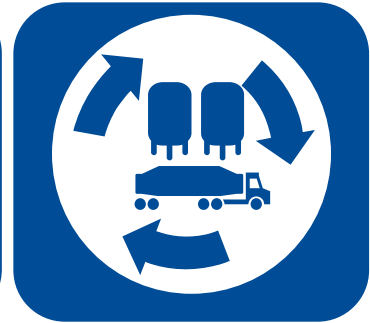
>15 years and >20 large installations in municipal/ industrial segments & > 1,000 POET GAC systems treating residential well sites



GAC is safe & environmentally responsible - safest way to treat is to remove contaminants



Cost effective & simultaneously removes other emerging contaminants which addresses future compliance requirements

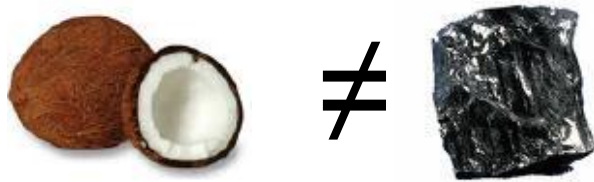


Reactivation of spent GAC thermally destroys adsorbed contaminants including PFC's

Activated Carbon Differentiators

Impact of Raw Material

- Coal, Coconut, Lignite, Wood
- Ash impurities inherited
- Density and hardness are linked
- Transport pore structure and adsorption kinetics
- Single unique family of products from a raw material source
- Coconut \neq Bituminous Coal

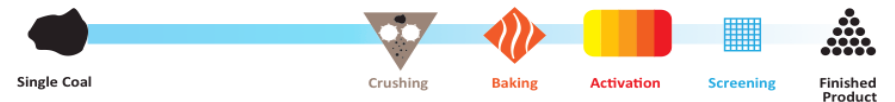


Impact of Manufacturing Process

Reagglomeration

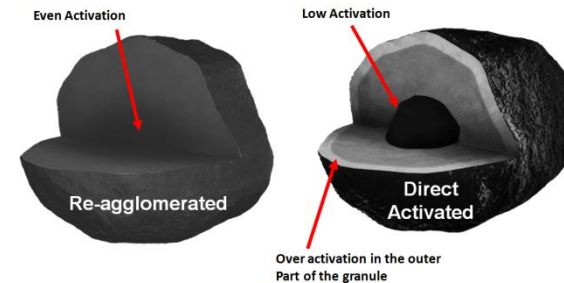


Direct Activation



Reagglomerated products exhibit:

- Even activation
- Superior Kinetics

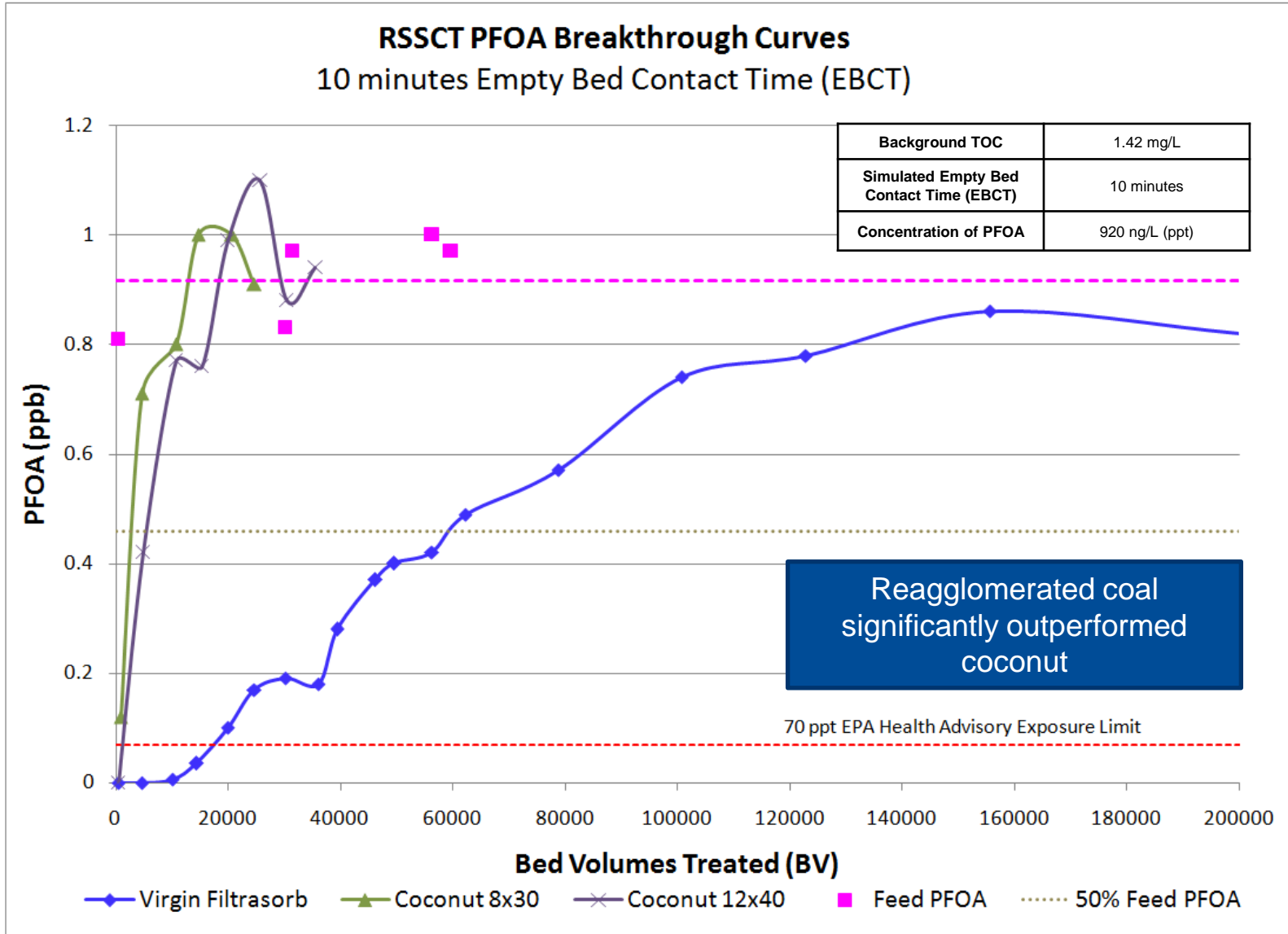


Filtrisorb® is a re-agglomerated product that is manufactured in the United States

Importance Of Testing

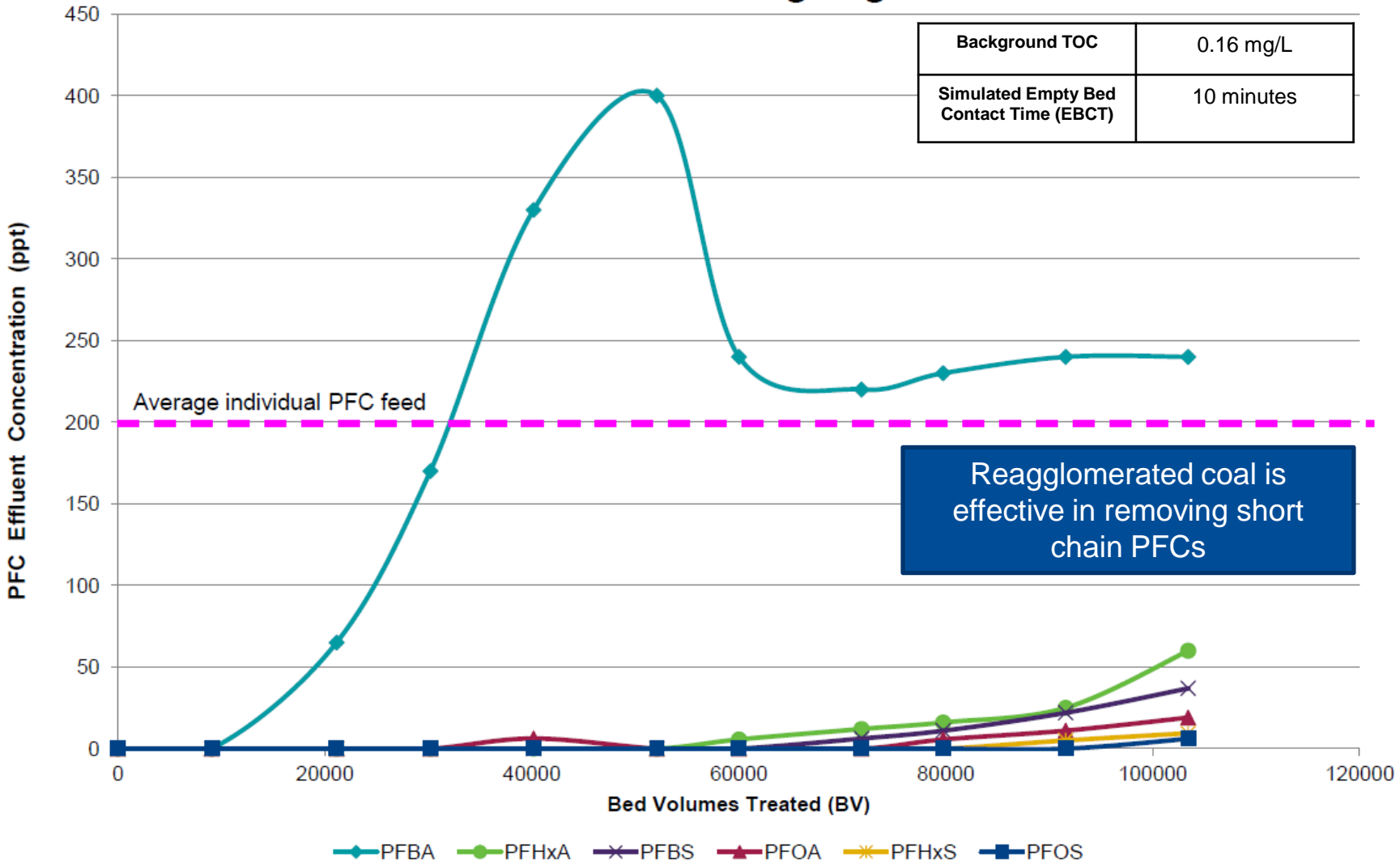
- **PFCs/PFASs are found in trace amounts in water**
- **Testing is recommended – Customer Raw Water Sample**
 - Isotherm- Quick Test Method for Feasibility
 - Accelerated Column Tests(ACT)- simulate full scale performance
 - Carbon type
 - Breakthrough Data
 - Usage rates
- **Water Treatment applications**
 - Typically low PFOA concentrations (ppb, ppt)
 - Background TOC can be 10-100X the PFOA concentration
 - Modeling such scenarios is difficult (even with other, non-PFC compounds)
 - ACT or RSSCT is beneficial
- **If client timing does not permit testing, CCC recommends as a start, 10 minutes EBCT (Empty Bed Contact Time) per adsorber, with 2 adsorbers in series for ppt/low ppb levels**

RSSCT PFOA/PFOS Test Data



RSSCT Short Chain PFAS Test Data

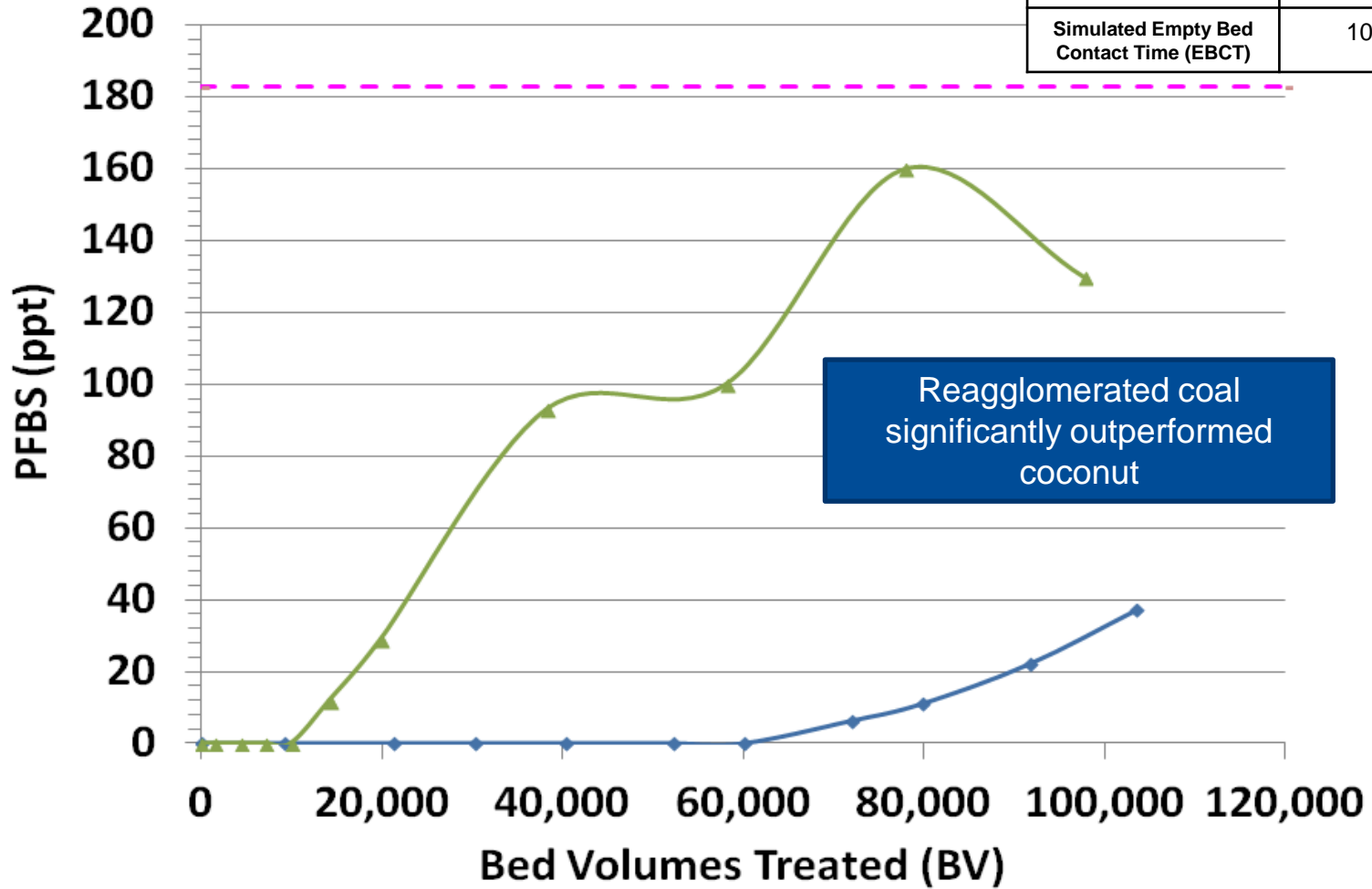
Removal of various PFCs using Virgin Filtrasorb



RSSCT Short Chain PFAS Test Data

Removal of PFBS using Filtrasorb vs. Coconut

Background TOC	0.16 mg/L
Simulated Empty Bed Contact Time (EBCT)	10 minutes



Reagglomerated coal significantly outperformed coconut

Key Takeaways

- Activated Carbon is the leading technology for PFAS/PFC removal from drinking water and groundwater
 - Proven for PFAS/PFCS and is the Best Available Technology (BAT) for other organic compounds
 - RSSCT data suggests GAC is effective for both PFOA/PFOS and short chain PFCs
 - Spent media can be reactivated
- Not all activated carbons are created equal
 - Impact of raw material
 - Impact of manufacturing process
- Column testing is typically recommended (ACT or RSSCT)
 - If time does not permit, series operation with 10 minutes EBCT per vessel (20 minutes total EBCT for the system) for ppt/low ppb concentrations



Questions?

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Website

- **PFC Page**
 - White Papers
 - Fact Sheets
- **Information Line**



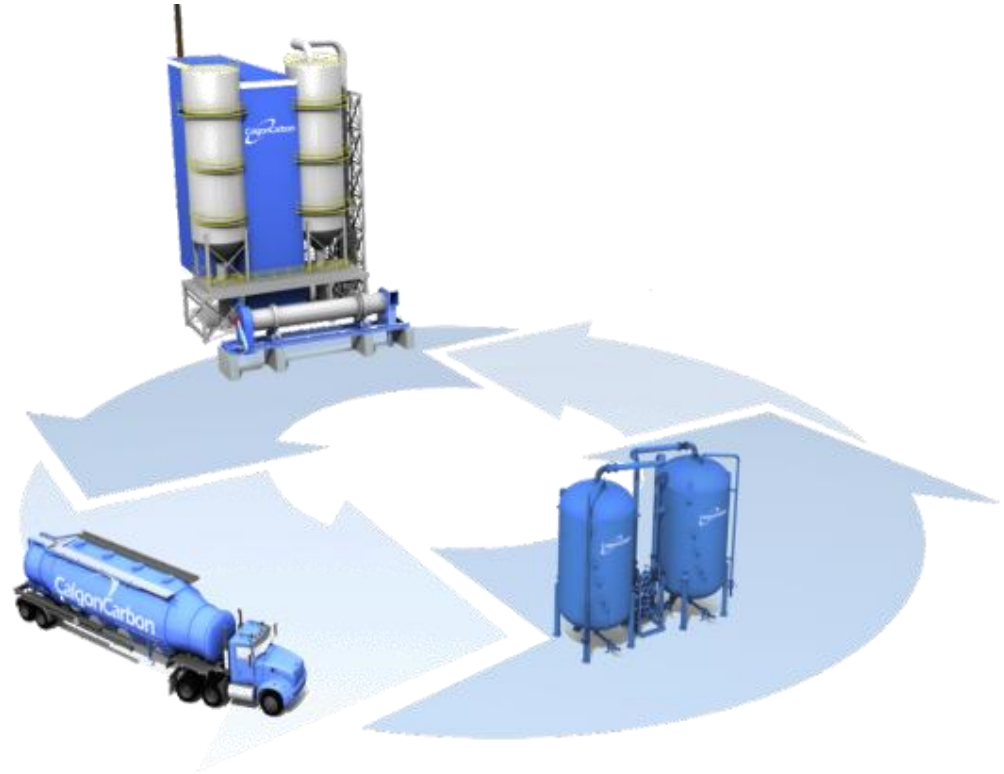
Reference Material



Reactivation

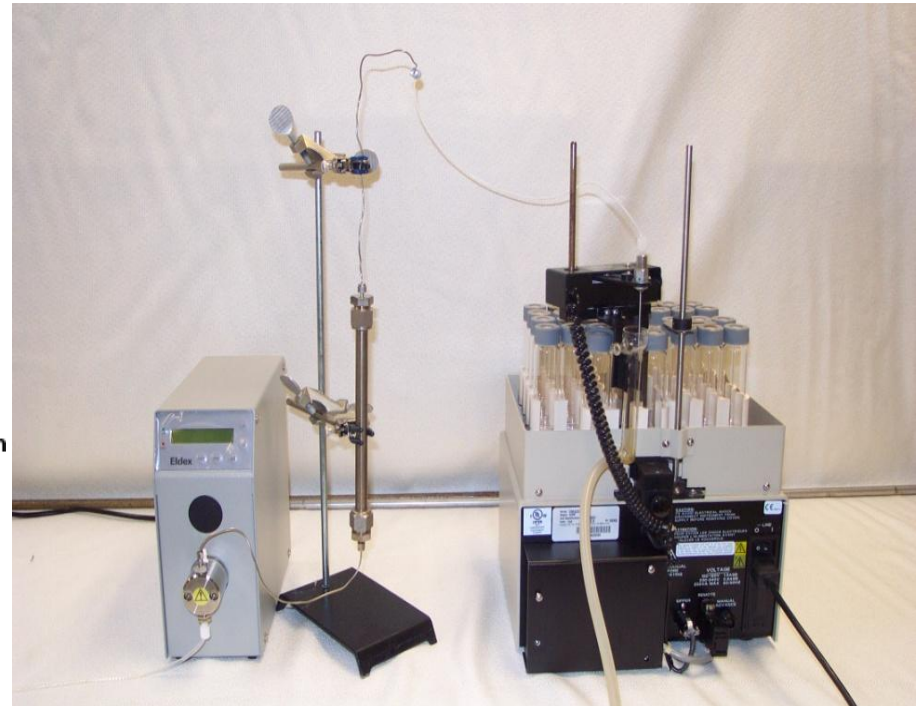
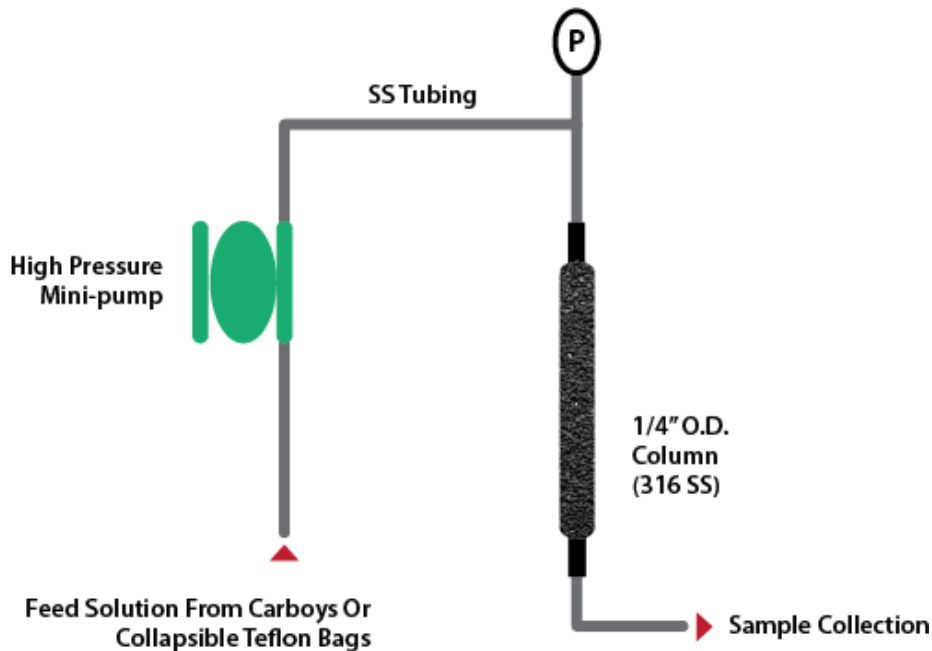


- Reactivation is the reprocessing (recycling) of spent activated carbon at elevated temperatures
- Heat destroys the adsorbed organic material in a safe and environmentally responsible way
- Carbon is then reusable
- Frequency of reactivation is dependent on application



Column Testing (ACT or RSSCT)

- **ACT**- Accelerated Column Test
- **RSSCT**- Rapid Small Scale Column Test



Calgon Carbon Liquid Phase Equipment

Equipment	Carbon (lbs)	Pressure (psig)	Maximum Range (gpm)
FLWSORB®	180	3 recommended	10
Small DISPOSORB®	165	7.5 maximum	10
Large DISPOSORB®	1,000	7.5 maximum	30
Protect™ TW	500 – 2,000	75	70
Protect™ LM Series	500 – 2,000	75	70 per vessel, operated in series
Protect™ LM Single	500 – 1,500	75	70
CR-5000	5,000	50	250
CYCLESORB®FP1	1,000	75	30
CYCLESORB®FP2	2,000	75	60
CYCLESORB®HP	2,000	75	60
Model 6 (2 vessels)	12,000	75	200 per vessel, operated in series
Model 8 (2 vessels)	20,000	75 – 125	350 per vessel, operated in series
Model 10 (2 vessels)	40,000	75 – 125	700 per vessel, operated in series
Model 12 (2 vessels)	40,000	125	700 per vessel, operated in series
Model 12-40 (2 vessels)	80,000	125	700 per vessel, operated in series
Model 14	60,000	125	1,030
Mobile Adsorber	14,000	35 – 65	250
Dual Module (2 vessels)	40,000	75	300 per vessel, operated in series
Dual Express (2 vessels)	40,000	75	300 per vessel, operated in series