StobbeDPF R&D project

Porous Silicon Carbide ceramics for separating particles from hot gases – such as from diesel engine exhaust gases – was all created during the period 1986 to 1994 by Stobbe Tech.

The R&D work was primarily financially sponsored by:

- Danish Department of Energy's Research 1987 to 1992, R&D project for scientific studies of porous structures for diesel particulate filters and hot gas dust filters with a 2 mil € budget.
- Danish Department of Industry 1991 to 1994, development project for ceramic hot gas filters with a budget >1 mil €
- Per Stobbe

It all started with the shown canned 5.66×6" Cordierite Wall-Flow-Filter (WFF) tested at Per Stobbe's final thesis at DTU (The Danish Technical University) in 1985. It took only one hour on a 3 cyl Buck diesel engine couple to a Schenk dyno to destroy, melt the center out of the first Cordierite WFF ever in Denmark. This raised the question – how can our international society solve the diesel engine particulate emission problem with WFF based on this fragile material?



The photo taken outside Stobbe Tech 1992 in Gentofte, Denmark you see from the left: Tim John Powel, Kenneth Partch, Svend Petersen, Per Stobbe, Rene Nielsen, Henrik Guldberg Petersen, Lars Tinggard Johannessen, Jakob W. Høj, Flemming Petersen.



The Copenhagen City Community and City Bus Authorisation requested a DPF technology to improve the air quality in the city. This huge task was given to Stobbe Tech supported by the Danish Technical University with national funding.

Project title: "ReSiC as a material for diesel particulate filters"

Funded with 2 mio € budget by Danish Department of Energy's Research

Project period: 1988 – 1994

This remarkable technology allows large, complex dimensions and high porosity structures to be shaped from relatively low-cost coarse grinding SiC grain by extrusion. The bodies dried with only 2% shrinkage and fired at 2500°C with only 1% shrinkage, such low shrinkage figures are quite unusual in the ceramics industry. All was developed from scratch - the complete basic science and the manufacturing methods, all the manufacturing equipment such as the complicated extrusion die heads, the wear resistant extruder, the 3 dimensional drying methods / equipment and in particular the challenging design and construction of furnaces capable of operating at 2500°C in controlled atmosphere.

Over 8 years ahead we were 9 people focusing on developing the bi-modal ceramic method based on SiC grinding powder mixed with an organic binder to manufacture porous honeycombs. The entire set of production equipment, all the related technologies and even real-life testing on a high number of different vehicles was developed. An impressive achievement for such a small company! At this time no large company had even thought about this principle for "low-cost" manufacturing of porous ceramics.

Stobbe Tech received valuable help from:

- Associated professor Spencer C. Sorenson at Department of Energy Techniques at The Danish Technical University
- Associated professor Jakob Weiland Høj and Associated professor John Emil Engell from Department of Mineral Industry at The Danish Technical University
- Associated professor Athanasios Konstandopoulos from CPERI in Greece
- Richard Utzschneider from Norton GmbH in Bexback, Germany now MD at Saint Gobain Industri Keramik, SGIK in Rödental, Germany

This project and initial work became the fundament for numerous technologies, created many jobs and improved the quality of life for humans in general hereafter. In general the technology used for DPF purposes was 10 years ahead of its time or the legislation 10 years behind!

The experienced reader will know the Japanese company Ibiden at the same time in parallel developed their quite different mono-modal SiC technology based on more expensive finer SiC grain. Further the experienced readers are aware that three different ceramic material technologies are dominating the market for DPF and competing:

- Cordierite from Corning and a variety of manufactures being an oxide ceramic characterized by very low thermal conductivity and thermal expansion
- ReSiC mono-modal technology from Ibiden also manufactured by Saint Gobain SGIK
- ReSiC bi-modal the Stobbe Tech development a non-oxide ceramic material characterized by very high thermal conductivity and relative cheap manufacturing

The route in the western world to control particle emission from diesel engines has been long and troublesome. The better and more efficient diesel engines the more difficult it becomes to capture and combust the particles. The widely accepted way to reduce particulate emission is by filtering the exhaust gas through typically a high temperature stable Wall-Flow-Filter devise.

Cleaning up exhaust gas from diesel engines is though relatively easy with one of many different sizes of StobbeDPF, which has been commercial available since 1995 in 90-200 cell-per-square-inch (CPSI) design ranging from 1 to 40 litre of volume.



A range of segmented DPF and an advanced combined DPF, catalyst and muffler for a CAT.



Non canned SiC DPF monolith and one dual system integrating electrical heating installed on forklift truck.



Complete DPF package and one disassembled system integrating electrical heating.

Stobbe Tech developed and patented the bi-modal ReSiC honeycomb substrate (re-crystalized Silicon Carbide) concept for accurately controlled pore size, porosity and high permeability for capture of diesel engine exhaust particulates. Finally this turned into the 100% owned daughter company NoTox in 1992

Manufacturers of the StobbeDPF technology are among others:

- <u>www.dinex.dk</u>
- <u>www.liqtech.dk</u>
- <u>www.notox.com</u>
- <u>www.ctisa.fr</u>
- http://www.pirelli.com/environment/en/feelpure/feelpure-filter.html

You will find extensive information about engine emission at <u>www.dieselnet.com</u> and under research/gas filters on this website



Buses in Paris, Toronto and Copenhagen equipped with special designed DPF systems with additives.



Excavator and gravel machines equipped with custom designed Stobbe DPF for tunnel use. Kind of advanced as the kit combines DPF, catalyst and muffler here shown for CATs.



Complete DPF package for Toyota forklift truck ready to install into the narrow engine compartment.



Hundreds of Swiss manufactured Rolba road sweepers equipped with StobbbeDPF operating all over Europe.

Unfortunately, Per Stobbe lost 1996 all the technology, companies as to a hostile raid from a range of investors, the patent agent used for years and Danish banks.