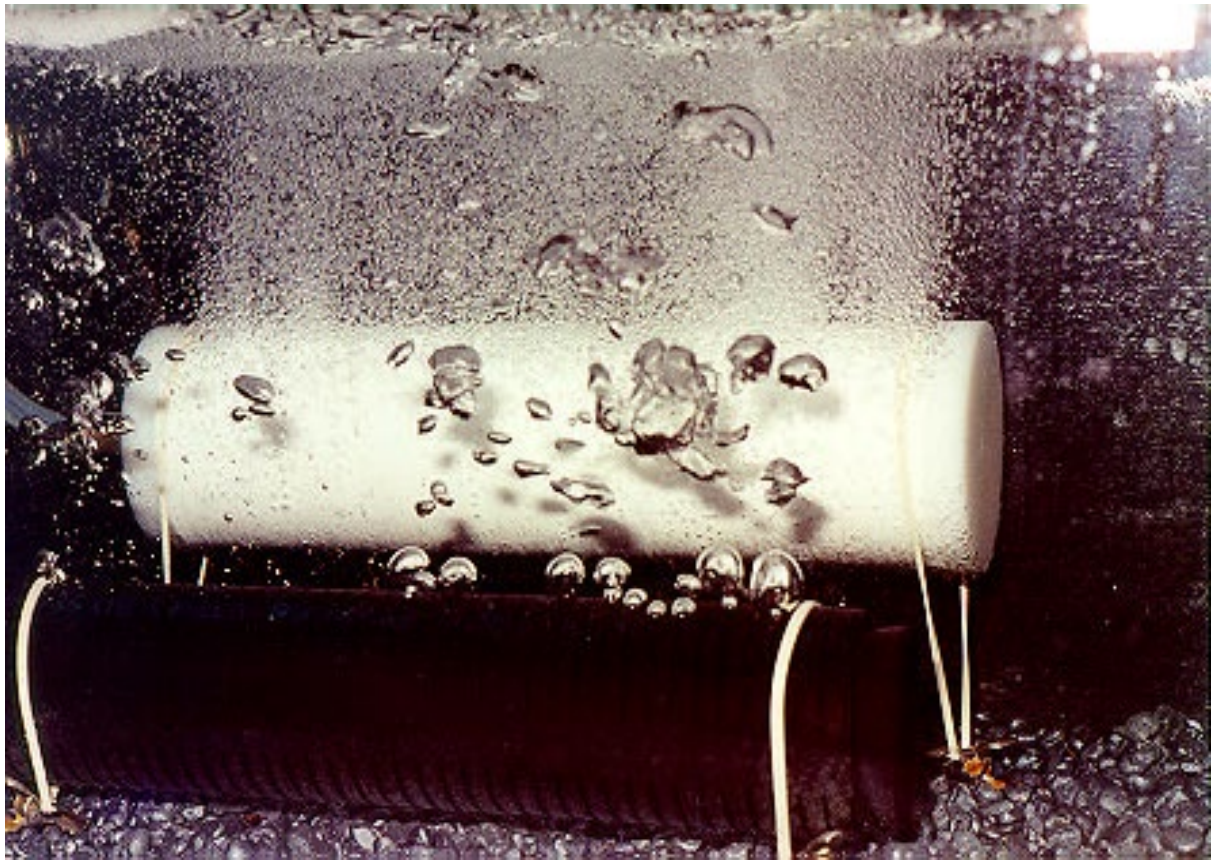
## High Density Porous Polyethylene Well Screen

# Environmental Technology for Remediation & Water Resource



**Air bubble formation from both the white SCHUMASOIL well screen versus a 0.02” slotted high density polyethylene**

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## General Description

### 1.1 Introduction

SCHUMASOIL® is a porous polyethylene well screen developed specifically to solve characteristic problems associated with slotted screens, the first of which is SCHUMASOIL's ability to provide a seamless transition between the formation and an extraction or injection well system.

The unique blend of high quality high density polyethylene (HDPE) beads along with an accurately defined sintering process which is time and temperature controlled, results in a matrix that is uniform and ductile. The sintering process creates bridges which connect one particle to another without additional binding agents. The result of this process is a consistent and uniform product.

Johnson Screens has the ability to accurately produce a predictable homogeneous pore size well screen product, which is available in four different pore sizes providing the user with the ability to match flow characteristics of the well screen to the surrounding formation. As mentioned, a very unique well screen property.

Figure 1: Bubble pattern as air is passed through a SCHUMASOIL well screen

SCHUMASOIL, a porous polyethylene well screen, minimizes flow resistance by providing a 35% - 45% porosity uniformly distributed along the entire length of the well screen. **Greater porosity, uniform pore distribution and predictable pore size** provide the user with the ability to **match flow characteristics of the well screen to** that of **the formation**.

Conventional well screen made of slotted polyvinyl chloride (PVC), slotted high density polyethylene (HDPE), or stainless steel screens were originally developed for water resource well applications to provide drinking water. Slotted materials generally have an open surface area of 5% -15%, and are best suited and most effective in coarse grained soils. Generally, slotted pipe has high entrance and exit velocities which can result in preferential flow and even cause formation fracking. Slotted well screens are susceptible to clogging due to breakthrough and intrusion occurring in fine and sandy soil conditions.

On the other hand, SCHUMASOIL well screen, with an **open surface area of 25 - 36%** depending on the pore size selection, was **developed for fine to coarse grained soils**. In addition to conventional **vertical wells** for water recovery, SCHUMASOIL is an excellent well screen for use in **horizontal wells**. The porosity of the material provides all the advantages of a filter pack, but without the associated installation and weight problems – ease of installation.

**1.2 Material Description**

SCHUMASOIL well screen is made from pure polyethylene with a specific particle size distribution which is formed into pipes or tubes by a specially developed sintering process. This process assures that each piece of SCHUMASOIL contains a uniform pore size distribution thereby providing the user with a performance capability unlike any other well screen material. The photo below, taken by a scanning electron microscope, displays the bead structure of the high density polymer used to create the SCHUMASOIL well screen.

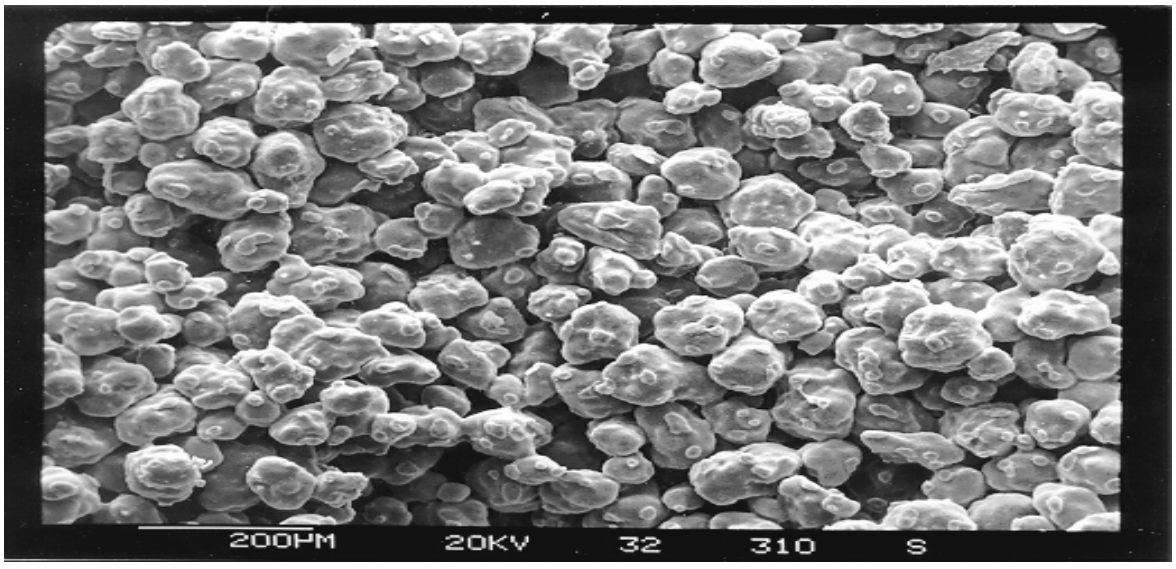


Figure 2: SCHUMASOIL well screen polymer structure

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The hydraulic conductivity ($K_f$ values) for SCHUMASOIL well screen material ranges from 24 to 283 ft/day ($8.5 \times 10^{-3}$ to $1 \times 10^{-1}$ m/s). By knowing the hydraulic conductivity of the well screen, the user can match the hydraulic characteristics of SCHUMASOIL to those of the formation thus allowing for a smooth transition into or out of the annuls. SCHUMASOIL is available in four (4) pore sizes to provide a range of hydraulic conductivities. For example, in areas of fine grain soils, the homogeneous pore sizes distribution enables the application of a specific permeable SCHUMASOIL well screen as compared to slotted conventional screens.

In addition to the four (4) pore sizes, Johnson Screens manufactures SCHUMASOIL in four (4) pipe size diameters which are 1, 2, 4, and 6 inches. More physical details about SCHUMASOIL are provided in subsequent pages. The photo below illustrates the size variations of SCHUMASOIL.

Figure 3: SCHUMASOIL well screen of different dimensions

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**Advantages of SCHUMASOIL Polyethylene Well Screen**

The following is a list of SCHUMASOIL's advantages which will be delineated later in the documents.

- Highly porous with a homogeneous pore structure
- Predictable permeability
- Predictable pressure drop
- High permeability for water, soil vapor and solvent phases
- Wide range of chemical resistance including TCE, BTEX
- Low sorbability
- Light weight
- High radius of curvature
- Hydrophobic
- Lipophilic
- Inert material
- Low long term well operating costs
- Six different pore sizes offered to match soil formation characteristics
- Environmentally friendly
- Available reinforced for horizontal well applications

## 2. Range of Applications

### 2.1 Application Examples

The selection of SCHUMASOIL pore sizes and pipe diameters offer a wide range of applications in various types of soils.

- **200 µm -** used in fine sand & fine grained soils, & for water resource wells.
- **40 µm** & **80 µm -** suitable for sandy, silty areas.
- **20 µm** & **40 µm -** provide superior sparging and soil vapor extraction.

The small pore sizes are also suitable for treating problems such as contamination with mineral oil hydrocarbons.

The varying pore size ranges offer the following application opportunities:

- **Soil vapor extraction**
- **Sparging**
- **Bioremediation**
- **Free product recovery**
- **Ground water extraction**
- **Drainage**
- **Seepage pipes**
- **Degassing**
- **Passive attenuation**
- **Water resource wells**

In Tables 1 and 2 we deal more specifically with the properties, attributes and advantages of SCHUMASOIL.

Table 1: Properties & Advantages of SCHUMASOIL

| Physical Properties | Advantages |
|---|---|
| Homogeneous pore structure | ➢ Provides a defined and constant pressure drop through the well screen wall.<br>➢ The predictable performance provides efficient well design, thereby lowering overall operating costs.<br>➢ Provides a low pressure drop and a uniform resistance to flow.<br>➢ Provides an even injection or extraction of gases and liquids. |
| HDPE - High Density polyethylene polymer matrix | ➢ Chemical resistance offers application in areas where other well screens such as stainless steel or PVC cannot be used. |
| PE is non-polar material | ➢ Inhibits fouling of the well screen |
| PE polymer has no micro porous surfaces (<1 um) | ➢ Inhibits fouling of the well screen |
| Low sorbability | ➢ IProvides a thorough desorption in remediation applications. SCHUMASOIL poses no threat to the environment following completion of the clean up. |
| Porous spherical matrix | ➢ Allows SCHUMASOIL to be installed in areas where a filter pack is needed but cannot be installed, such as horizontal applications or flowing sands. |

| Physical Properties | Advantages |
|---|---|
| Pipe diameters and pore | ➢ Offer dual pipe configuration allowing air and water |

| | |
|---|---|
| sizes | extraction within the same bore hole. |
| Durability | ➢ Offers a wide range of applications. |
| Lipophilic | ➢ Attracts oil. |
| Hydrophobic | ➢ Repels water |
| Low pressure drop | ➢ Reduces energy demand during the life of the well. |

Table 2: Advantages of SCHUMASOIL

| Properties | Advantages |
|---|---|
| Lightweight | ➢ One four meter section of 6" weighs less than 55 lbs which means the product is easy to transport and install. |
| Ductile | ➢ High radius of curvature. Install in locations with limited access. |
| Fusing properties | ➢ SCHUMASOIL four meter sections can be butt-fused using standard welding machines with slight modifications for metric pipe sizes. |
| Connectors available | ➢ Although SCHUMASOIL is manufactured in metric pipe sizes, connectors are available to match US Standard pipe sizes. |
| Recommended carrier casing installation method | ➢ Provides added collapse strength and tensile strength.<br>➢ Aids in well development. |

## 3. Commercial Development

Over several years SCHUMASOIL was successfully used in a multitude of applications. The well screen performed successfully in both saturated and unsaturated conditions. Its attributes make it suitable for various remediation applications such as **soil vapor extraction**, **air sparging**, **ground water extraction, bioremediation** and **free product recovery**. In addition to the remediation applications, SCHUMASOIL was also successfully used in **soil stabilization** and **drainage, seawater recovery, rehabilitation of fresh and salt water ponds and lagoons, and industrial settling ponds**.

Today, thousands of both vertical and horizontal wells are equipped with SCHUMASOIL well screen, but prior to commercialization more than 150 field test wells were installed along with laboratory tests carried out in connection with the development of the SCHUMASOIL well screen.

In the early 1990's SCHUMASOIL was born out of a vision of the need for a porous well screen by a young geological graduate student at Karlsruhe University along with the cooperative commercial efforts of U.S. Filter/SCHUMACHER Umwelt- und Trenntechnik GmbH, Crailsheim, Germany. The original application concept for SCHUMASOIL well screen material was for horizontal well applications. It was the opinion of the young geological graduate student that a single horizontal well of SCHUMASOIL would be more efficient and effective than many vertical wells of slotted screen material. The perception of one horizontal well of SCHUMASOIL displacing a multitude of vertical wells offers an opportunity to reduce costs and simplify the remediation process and more effectively remediate the site in question.

The commercial viability of the porous well screen began to materialize in 1992 with the first SCHUMASOIL horizontal well installation for soil vapor extraction followed by three more soil vapor extraction well installations in 1993. By 1994, ten more horizontal installations for soil vapor extraction, soil stabilization, in-situ ground water treatment and free product recovery were completed. Also, 1994 marked the first commercial installation of SCHUMASOIL in the United States with two in-situ ground water treatment horizontal wells. There were sixteen more horizontal installations in 1995, and so the story goes.

In 1998, U.S. Filter introduced the SCHUMAprobe product line to meet the direct push technology demands for vertical well installations. SCHUMAprobe was almost an overnight success and is now systematically used for air sparging and groundwater monitoring.

## 4. Technical & Physical Data

The following data is presented to better identify the specifics concerning SCHUMASOIL. This information is general in nature and represents average values for the product line and should not be considered as specifications.

Table 4 provides a SCHUMASOIL application reference vis-à-vis soil permeabilities.

Table 4: Cross Reference of Soil Permeability for SCHUMASOIL

| SCHUMASOIL | Used in soils with permeability of |
|---|---|
| **200 µm** | < 85 m/day or < 279 ft/day or < 2,100 gpd/ft2 |
| **80 µm** | < 27 m/day or < 89 ft/day or < 664 gpd/ft2 |
| **40 µm** | < 16 m/day or < 52 ft/day or < 380 gpd/ft2 |
| **20 µm** | < 8 m/day or < 26 ft/day or < 180 gpd/ft2 |

Table 5 provides the physical dimensions of SCHUMASOIL well screens.

Table 5: SCHUMASOIL Well Screen Pipe Size (PS) Physical Dimensions

| | Item | PS 1” | PS 2” | PS 4” | PS 6” |
|---|---|---|---|---|---|
| **Outside Diameter** | in<br>mm | 1.315<br>33.4 | 2.375<br>60.3 | 4.50<br>114.3 | 6.625<br>168.3 |
| **Inside Diameter** | in<br>mm | 0.959<br>24.4 | 1.885<br>47.9 | 3.74<br>95.0 | 5.825<br>148.0 |
| **Wall Thickness** | in<br>mm | 0.178<br>4.5 | 0.245<br>6.2 | 0.380<br>9.7 | 0.400<br>10.2 |
| **Cross Section** | in²<br>mm² | 0.636<br>410 | 1.639<br>1,058 | 4.918<br>3,173 | 7.823<br>5,047 |
| **Weight/Length** | lbs/ft<br>kg/m | 0.17<br>0.25 | 0.43<br>0.64 | 1.28<br>1.91 | 2.04<br>3.03 |

Table 6 provides technical data for SCHUMASOIL well screens.

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Table 6: Table of physical data for reinforced and non-reinforced SCHUMASOIL

| | Item | 20 µm | 40 µm | 80 µm | 200 µm |
|---|---|---|---|---|---|
| Porosity | % | 40 | 42 | 45 | 45 |
| Free Surface Area | % | 32 | 34 | 36 | 36 |
| Average Pore Size | µm | 20 | 40 | 80 | 200 |
| Hydraulic Pore Size | µm | 30 | 50 | 100 | 120 |
| Max. Pass Through Grain Size | µm | ≤ 8 | ≤ 20 | ≤ 40 | ≤ 80 |
| Hydraulic Conductivity Kf | m/s | $5.0 \times 10^{-5}$ | $1.0 \times 10^{-4}$ | $1.0 \times 10^{-3}$ | $4.0 \times 10^{-3}$ |
| Pressure Drop 1 | mbar | 16 | 7 | 4 | 1.3 |
| Tensile Strength not reinforced | psi | 220 | 600 | 550 | 400 |
| Max. Temperature | °C/°F | 80/176 | 80/176 | 80/176 | 80/176 |

1 Pressure drop measured with air at ambient temperature, a face velocity of 250 m/h, and a bed depth of 10 mm.

## 5. General Care & Handling Instructions

### 5.1 Handling

Be very careful when transporting the product in order to avoid damages caused by careless loading and unloading.

- ♦ The product may be handled only at the marked points.
- ♦ Do not throw packages or individual well screens.

### 5.2 Intermediate Storage

Avoid damage which could be caused by improper storage and handling of the product.

Should there be a significant installation delay of well screen after the product is on site, please follow the these instructions which should be strictly adhered to:

♦ Protect against exposure from direct sun light. Excessive exposure from the sun could cause the product to distort over time due to thermal influences.
Remove the product to a covered facility or erect a cover over the exposed well screen.

♦ Well screen must be stored on a flat and even surface.

♦ Do not stack other material on top of the well screen.

♦ During the storage period, try to limit movement of the material so as to reduce potential transport damage.

All storage recommendations are designed to maximize SCHUMASOIL's performance potential and to provide our customers with what they paid for and therefore expect in performance.

If there are any questions concerning the information presented within this brochure please contact Johnson Screens. 1-800-833-9473

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