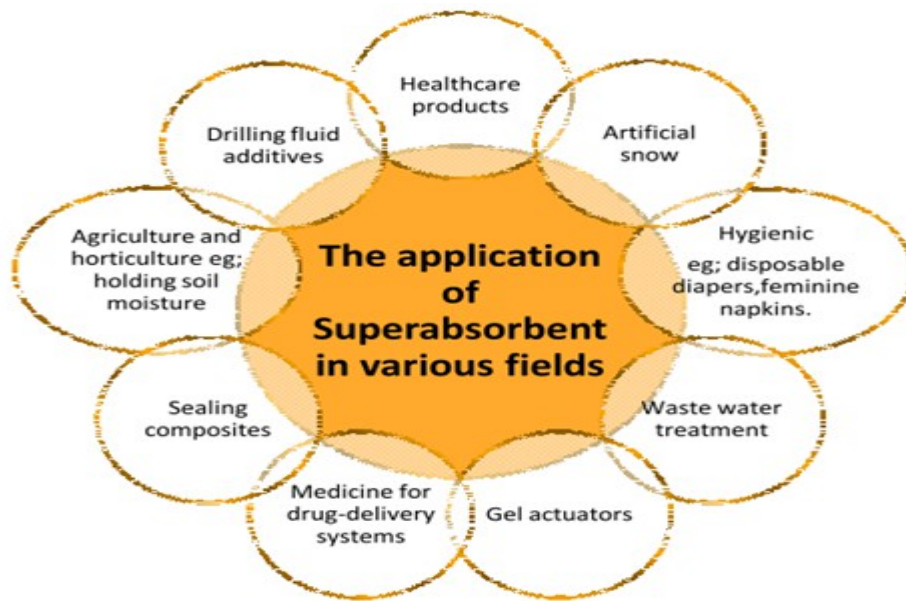


Applications of the Super Absorbent Polymers

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Due to their outstanding characteristic, super absorbent polymers (SAPs) have been used in many applications. Figure 1 reflects some of .these uses



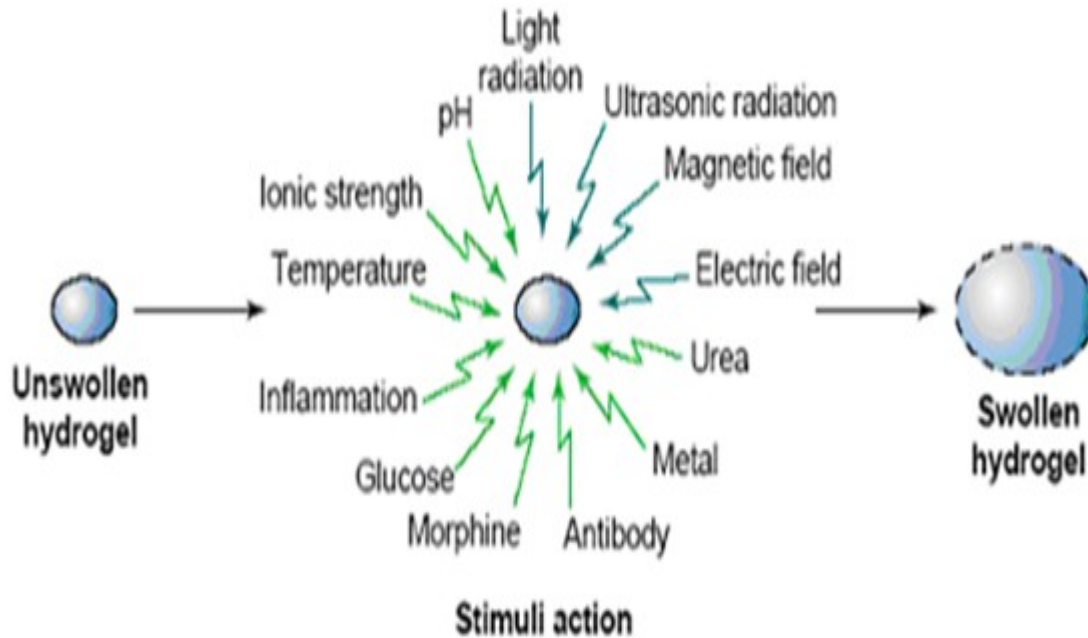
[Figure 1: SAPs applications in various fields [1

Smart Applications .1

Smart hydrogels are sensitive to environmental changes which may be physical or chemical variations like fluctuations in magnetic field, photo-irradiation pH, temperature, urea, glucose and solution's ionic strength (Figure 2). Smart hydrogels used in many applications such as biosensors, actuators (artificial muscles), self-regulating drug delivery systems, on-off regulation of enzymatic reactions and purification of . chemical agents

The pH-response polymer gel is an example of smart hydrogel which can responds to the environmental pH variations similar to variations

occur within the human body. pH values can change greatly between injured and infected tissues. For example normal tissue fluid has a pH ≈ 7.4 , but it can be as low as 3.5 in a wound, and increase to 9.0 for an .[infected wound tissue [2



[Figure 2: Swelling behaviors of intelligent hydrogels [1

Normally, the pH- responsive gel possesses a molecular structure contains cross-linked network with ionize-able groups within its network. These groups will ionize in different ionization levels analogs to the pH .and ionic strength levels
As the network structure changed with the surrounding pH, the H- bond is converted also, which in turn created changes in mass and volume of .the gel

Medical Applications .2

SAPs can be used in many medical applications, such as drug delivery systems (DDSs), wound closure , healing products, removal of body water during surgery(treatment of edema), and surgical implant devices [3]. SAPs, also used in the health care field to manufacture an efficient .heating pads to help patients whom suffer from rheumatism

One example of the control on–off drug release is the sugar responsive gel which is used for diabetes treatment. In healthy physiological conditions, cells in the pancreas releases insulin hormone to control blood glucose level within the range of 70 - 110 mg/dl. In contrast, for patients whom cannot control blood glucose levels, it is necessary to added insulin externally. Hypoglycemia and coma may result from the irregular .doses, thus insulin must be accurately added

Insulin hormone is produced from beta cells in the pancreas to control glucose levels in the blood. Diabetes disease arises when there is no .[enough production of this hormone [4

Recently, super-porous hydrogels (SPHs) have been developed with very fast swelling behavior due to their open porous structure in order to controlling the delivery of drugs to intestine or stomach, as well as for .[gastric retention applications [5

Agricultural Applications .3

SAPs inside the soil can absorb water from rainfall or excessive irrigation, then releasing it slowly upon the root demand through osmotic pressure difference, resulting in improved growth rate. Furthermore they can be used for the controlled release of pesticides and agrochemicals .[[6

SAP hydrogels can influence many properties of soil such as permeability, aeration,density, structure, erosion resistance, evaporation, microbial activity and infiltration rates. SAPs also used to increase both the nutrient retention andthe water-holding capacity for sandy soils (macro porous medium) in the arid areas [7]. Furthermore, SAPs can reduces both of the losses of water, irrigation frequency and soil .[compaction tendency [8

For plants, SAPs can increase color intensity, coverage percentage and sport turf density, and decreases it's wilting level. SAPs in agriculture can be used as mixtures with soil, seeds, agricultural chemicals, and fertilizers(called water-absorbent slow release fertilizer).For forestry field, SAPs is covered over the roots to protect tree from drying during transportation

Strengthening of Concrete Application .4

Although mortar and concrete are popular construction materials, but they sever from some weaknesses such as late hardening, large drying .shrinkage, low chemical resistance, and low tensile strength

SAPs can act as an internal water source to provide hydration process :[with the required water according to the following mechanism [9
SAPs absorbs water molecules from the fresh concrete mixture, then -1 releases it in a later stage if its relative humidity decreases because of the .hydration process

When SAPs have got their final sizes, they establish stable, water- -2 filled inclusions, then water will sucked from these inclusions into smaller capillary holes and consumed by the cement hydration action .[[10

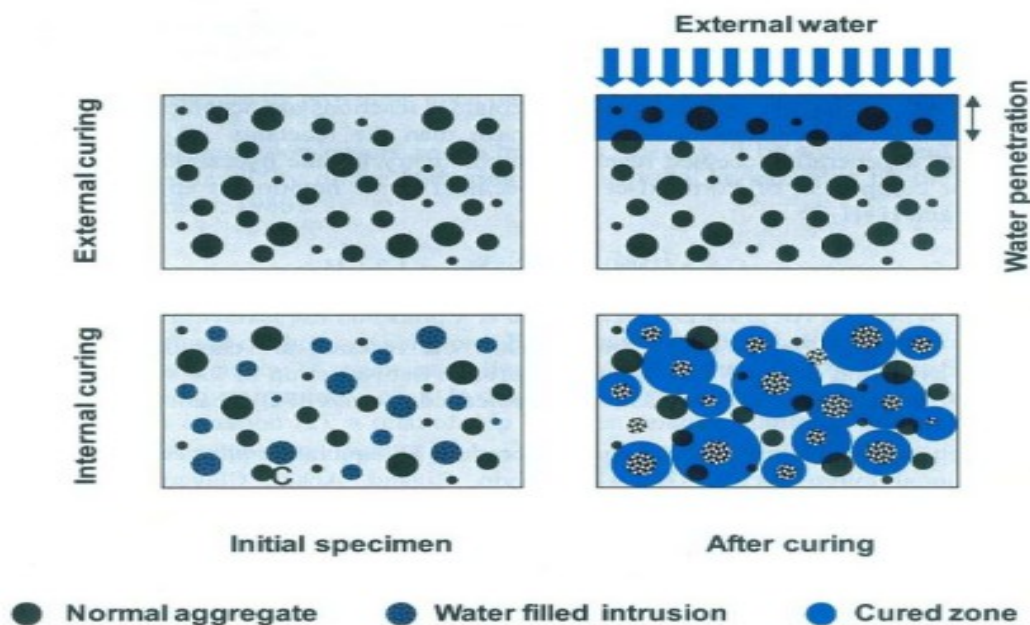
SAPs can be used to promote internal curing of concrete; thus mitigate its autogenous shrinkage. This is because internal curing allows curing to be 'from inside to outside' by the created internal reservoirs; thus provides water throughout the mix not just penetration for a few millimeters such .[as in external curing (Figure 3) [11

Also, the created gel can improve both the workability and stability due .[to provide the concrete mass with cushioning and lubrication effects [12

Effective mortar properties are the consistency and the setting times. Consistency of standard paste refers to the water content of the .paste which will produce the wanted consistency

Setting indicates the change from a fluid state to a rigid state and mainly caused via the hydration of tricalcium silicate (C_3S) and tricalcium aluminate (C_3A) and occurs in two stages; initial and final sets

Setting is important in concrete work to keep fresh concrete plastic for enough time which helps the processes of transporting, casting, and .[compaction [11



[Figure 3: Internal curing vs. external curing [11

Initial set considers as the time elapsed since the moment of mixing water with the cement to the moment of penetration of no deeper than 4-6 mm from the bottom. The minimum initial set time is 45 minutes according to the ASTM C 150-09

The final setting is usually calculated from the moment of mixing water with the cement. There are no limits appearing in the European or .[ASTM standards for the final setting time [12

Other Applications .5

SAPs can be used also in many applications such as, fire retarders, dewatering of adulterated fuel, artificial snow [13], athletic garment, ornamental (colored) products, sanitary towels, building internal decoration[14], modifying weather condition, as dehydrating agent to solidify waste in the sludge treatment ,absorb alcohol as well as the heavy metal ions like Co^{2+} and Cr^{3+} , extract urea from urine in artificial kidneys (urea absorbing material), to improve the moisturizing effects of different .[cosmetic products and cleaning radioactivity from porous structures [14

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