EUSA

EUROPEAN UNION OF SWIMMINGPOOL AND SPA ASSOCIATIONS

TECHNICAL PAPER

DOMESTIC SWIMMING POOL FILTRATION

There has to be an international understanding of certain words when producing any paper such as this. The word “REGULATION” means that there is a national law and is associated with the word “MUST”. The word “RECOMMENDED” means that there is no legal requirement but this is the EUSA suggested best way of working and is associated with the word “SHOULD”.

DOMESTIC SWIMMING POOL FILTRATION SYSTEMS

GENERAL

1. The filtration system in any swimming pool is to remove the suspended matter from the pool water. Filtration is achieved by passing the water through a suitable medium contained in a vessel.

2. It is generally accepted that there are three types of filters associated with swimming pools:
    a. Pre-coat filtration/Diatomaceous Earth (DE)
    b. Disposable Cartridge
    c. Graded Aggregate (Sand or other suitable material, in conjunction with or without layered shingle, anthracite etc.)

3. Particulate removal to 10 to 5 microns can be achieved with these systems and that has long been established as acceptable in swimming pools.

4. The efficiency of filtration is affected by the speed of the water through the filter medium and this is expressed as the volumetric flow through a square metre of medium per hour ($m^3/m^2/hr$).

5. The number of bathers and the cleanliness of their bodies in any swimming pool will also affect the design and/or selection of the filter therefore it is essential that this is discussed and specified at the pool design stage. Consequently there is a marked difference between the design of a commercial pool and a domestic pool.

6. The Filtration system, the Circulation system and the Treatment system form an integral part of the swimming pool for without one the others cannot function correctly.

7. This paper should be read in conjunction with other EUSA Papers.

PRE-COAT FILTRATION USING DIATOMACEOUS EARTH (DE)

8. Pre-coat filter vessels have an internal framework onto which is fixed a chemical resistant, durable and porous material. The framework is divided into sections known as septums. The water flow is engineered so that the water enters the vessel surrounds the septums and in order to leave it must pass through the material covering them. The water flow characteristic must be to ensure the greatest uniformity of flow through each of the septums so that, when the filter medium is drawn into the filter it coats the septums uniformly.

9. The medium used is Diatomaceous Earth or Volcanic Ash and should coat the septums to a thickness of no less than 1.6mm. It is usually introduced to the system through a chamber on the suction side of the pump. The volume of DE is usually set by the designer/manufacturer of the filter. The size of the filter is determined by the area coated by the DE.

10. The filter is cleaned of dirt by reversal of the water flow through the filter (backwashing) and discharging the dirt and DE to a suitable drain. It is usual to incorporate a pressure gauge and air relief valve in the filter design. Particulate removal down to 5 Microns can be achieved at a filtration rate of $50m^3/m^2/hr$.

11. While the filtration efficiency of these filters is high there is a serious health risk when handling the diatomaceous earth and for this reason these filters are not widely used and in some countries they are banned.

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DISPOSABLE CARTRIDGE

12. The cartridge filter is a formed folded roll of dense porous material which is inserted into a vessel. As with the DE filter the water flow is engineered so that the water enters the vessel surrounds cartridge and in order to leave the vessel must pass through the material.

13. Once the material has been saturated with both water and debris the cartridge is removed from the vessel, cleaned and replaced. Once the cartridge has become worn with use and cleaning it is thrown away and replaced.

14. Again particulate removal to 5 Microns can be achieved. While these filters are efficient and light their use is limited to small or specialised pools due to cartridge cleaning difficulties.

GRADED AGGREGATE (Sand or alternative equivalent filtration)

15. The sand filter vessel contains a bed of graded sand through which the water is pumped. The pressure of the water compresses the sand and makes the microscopic gaps between each grain of sand even smaller and therefore effecting the removal of the suspended matter. At the bottom of the contained is a collection of outlet pipes (under drains) which allow the passage of the water but not the sand.

16. The top influent pipes (spreader) should be above the surface of the sand bed to allow expansion of the bed when the water flow is reversed through it for cleansing purposes.

17. The bed of sand can be supported by a secondary bed of shingle or even layers of graded shingle depending on the design of the filter. It is important that the filter designer stipulates the depth of the sand bed to be used.

18. Sand filtration is defined by filtration rates as follows:
    a. Low Rate — 0 to 10$m^3/m^2/hr$
    b. Medium Rate — 11 to 30$m^3/m^2/hr$
    c. High Rate — 31 to 50$m^3/m^2/hr$

19. Sand filtration can achieve particulate removal to 7 to 10 microns

LOW RATE SAND FILTRATION

20. Low rate sand filtration comprises a base bed of single or multiple layers of graded aggregate no greater than 300mm deep and composite layers no more than 100mm each. This supports a bed of fine silica sand with a particle size of 0.83mm to 1.3mm and with a uniformity coefficient of 1.45 to 1.69.

21. It is usual to use a flocculent on the surface of the sand to aid filtration and to assist backwashing by the addition of air scouring. Air scouring also helps to cut down backwashing time due to the low flow rate.

22. Backwashing is determined by the differential of the influent and effluent pressures as set by the manufacturer and should be done regularly to prevent dirt penetrating the sand bed.

MEDIUM AND HIGH RATE SAND FILTRATION

23. Medium and high rate filtration will use 16/30 grade sand (Particle size 1 to 0.5mm uniformity coefficient less than 1.4). It is not essential to have a supporting bed of shingle and the high flow rates dispenses with the necessity for air scouring. The hydraulic design of the water flow through the filter is also of greater importance to ensure the uniform flow of water through the sand bed.

DOMESTIC SWIMMING POOL FILTRATION SYSTEMS

BACKWASHING

24. As sand bed depths are greater, from 1 metre in commercial filters, it is necessary to ensure that the backwashing flow rate at least $30m^3/m^2/hr$.

25. Some systems used a layer of coarse grade shingle at the base of the sand so that the water flow around the under drains is less restricted and a better flow can be achieved. However it is some times difficult to level this layer. It is also common to pump air through the through the filter during backwashing in order to assist the fluidisation of the sand bed.

26. Any backwash water must be discharged into an appropriate drain close to the filter and the water disposed according to local regulations.

27. Backwash pipework should be fitted with a viewing glass to allow the operator to properly gauge the length of the backwash.

28. The disposal of the backwash water must be in accordance with National Norms.

FILTER VESSELS

29. All filter vessels should be designed and manufactured according to national and international standards. In general they should be designed to work at a pressure equivalent to 1.5 times the shut off pressure of the pump employed, in the case of steel tanks to withstand a crushing pressure equivalent to a vacuum of 50mm of mercury with a safety factor of 3.5 and be tested before leaving the factory.

30. They should be fitted with a pressure gauge and if necessary influent and effluent gauges, air relief valve, and in the case of manual valve backwashing have a manifold comprising five valves to allow for rinsing.

31. It is also possible to increase the available filter area by constructing vessels with vertical tiers.

ALTERNATIVE FILTRATION SYSTEMS

32. Membrane filtration for swimming pool water treatment is still in development for many reasons but also already in discussion for technical standards.

33. The efficiency of membrane filters compared to sand filters or multiplayer filters is higher. Different types of membrane filters are used i.e. Reverse Osmoses, Ultrafiltration or Microfiltration depending on the size of particles which should be removed. Sand filters can remove particles down to 10 microns, Ultrafiltration down to 0.01 micron.

34. Zeolites are an active filtration medium and can remove ammonia and some heavy metals. It is essential that the material is free from dust as this can block the flow of water. Additionally zeolites have to be regenerated by soaking in sodium hypochlorite.

35. The use of alternate media should be considered only if the water quality outlined in EUSA paper can be maintained.

MAINTENANCE

36. All filters and filter media must be inspected regularly to ensure that there is not a build-up of detritus thus preventing good filtration. Their design should incorporate a satisfactory means of removing the sand and where necessary this should include access hatches to allow full entry into the filter. Care should be taken to ensure the safety of the operatives and particular attention should be taken in regard to local

regulations regarding working in confined spaces. The disposal of any used sand should also be in accordance with local regulations.

FLOCCULATION/COAGULATION

37. The use of flocculants/coagulants has long been used to assist in the enhancement of water quality and in some cases the maintenance of ph. It is particularly relevant in the removal of the Cryptosporidium cyst which occurs in human faeces and is virtually impervious to disinfection. Consequently it has to be removed by filtration.

38. Aluminium Sulphate, Polyaluminium Chloride or Aluminium Hydroxychloride, Polyaluminium Sulpho-silicate, iron chlorides, and iron sulphates have all been used. They form a gelatinous precipitate by hydrolysis on the surface of the sand bed and are removed by backwashing.

39. Flocculants are not used in cartridge and DE filters.

PUMPS

40. The design of the filtration system will depend entirely on the correct selection of the filter pump. Its size and performance should be matched to the size of the filter and the filtration rate required.

41. The pipework sizing to account for the head loss in the system will have been carefully calculated however a balancing valve on the immediate pressure side of the pump should be fitted so that the correct flow rate can be achieved either by using the in-line flow meter or the published pump performance curve.

42. Pumps should be fitted with a pre-filter or coarse strainer, if no an integral part of the pump, to prevent objects from fouling the impellor. Where practical they should be fitted below water level and mounted on a plinth and/or anti-vibration mounting.

43. All pumps must have the electrical rating IP55 and be electrically connected according to local regulations by a qualified, competent electrician.

APPLICATION

44. The selection of the correct filtration system by the designer will depend on many factors however the over-riding one is that of water quality as defined in the EUSA paper.

45. Domestic pools invariably use high rate filtration. However it is the duty of the pool designer to select the correct filtration rate depending on the use of the pool, volume of water, the design bathing load and the chemical treatment design.