宗全利,郑铁刚,刘焕芳,李强强,郑华平.滴灌自清洗网式过滤器全流场数值模拟与分析[J].农业工程学报,2013,29(16):57-65

滴灌自清洗网式过滤器全流场数值模拟与分析

Numerical simulation and analysis on whole flow field for drip self-cleaning screen filter

投稿时间： 2013-04-02 最后修改时间： 2013-07-19

中文关键词: 灌溉,流场,数值分析,自清洗网式过滤器

英文关键词:irrigation folw field numerical analysis self-cleaning screen filter

基金项目:国家自然科学基金项目（50909062，51269028）；石河子大学科技成果转化项目（kjcgzh2011-03）

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中文摘要:

为了全面了解现有自清洗网式过滤器内部水流结构和特性，为进一步结构优化提供依据，该文采用Fluent(6.3)软件对其进行了全流场数值模拟。在分析过滤器结构及
洗原理基础上，建立了过滤器内部流场的数学模型和自清洗系统的动网格模型，给出了过滤过程和自清洗过程计算区域和网格、以及进出口边界条件，对比分析了自清
流量与进出口压力降关系模拟结果和试验结果。分析表明：模拟压降与实测压降符合较好，可以保证后续模拟结果的可靠性；在此基础上，对过滤过程内部流场进行了
拟，得到了水流流速、紊动能和压力的分布规律，分析了过滤器结构设计不足。运用动网格技术，对过滤器自清洗过程进行了数值模拟，通过流速、紊动能和压力分布
流场分析，指出了自清洗系统的不足，研究结果可为过滤器结构优化设计提供参考。

英文摘要:

Abstract: A self-cleaning screen filter has broad application on the domestic and foreign markets. The variation law of head loss, and the relationship between filtering time an
self-cleaning time have been analyzed through different experiments. However, the flow distribution of filter inside cannot be obtained by traditional experiment methods. To fully
understand the internal flow structure and characteristics of a self-cleaning screen filter and find the inadequacies of flow field distribution, the whole flow was simulated through
Fluent (6.3). Based on the analysis of filter structure and self-cleaning principle, the mathematical model of inside flow field and the dynamic grid model of a self-cleaning system w
established respectively, the computing area and the grid of filtering and self-cleaning processes, as well as boundary condition of inlet and outlet were proposed. In order to ens
the reliability of the simulation results, the relationship between the flow rate and pressure of a self-cleaning system were compared in this study, and the results show that the
simulated pressure agreed with the measured values. The internal flow field of the filtering process was simulated, and the distribution law of flow velocity, turbulent energy, and
average pressure were studied. The flow velocity decreases along the radial direction of the filter body, and it decreases rapidly from the inlet value of 2.6~3.0 m/s to the outlet val
1.4~1.8m/s. The maximum average pressure was located at the inlet of flow, and the average pressure of the first filtering chamber was significantly higher than the value of the se
filtering chamber, which the average pressure reduces relatively 25% and 80% after the flow passes the first and second filtering chambers. As the distributions of flow and turbul
energy are extremely uneven, the clogging of the entire screen is uneven. The design of inlet and outlet should be changed in order to avoid the uneven clogging of the entire scr
for example, several small-diameter screens replace a big diameter-screen. Moreover, through the technology of dynamic mesh, the process of self-cleaning was also simulated, an
flow fields of flow velocity, turbulent energy and average pressure were analyzed. The inlet of sunction will have a huge attractive power, which can ensure that the sediment of t
screen surface be cleaned. But the velocity, average pressure, and turbulent energy of sunction vary greatly at different heights of sunction. The maximum and minimum values of
velocity are located respectively at upper and lower sunction, and the maximum velocity difference is about 8.5m/s, which results in the lower screen being cleaned unthoroughly
the upper screen being damaged easily. The pressure gradient near the sunction is large, and the maximum pressure difference between outside and inside the sunction is about
1.1MPa. The maximum and minimum values of average pressure are located respectively at middle and upper sunction, which results in different cleaning efficiency at different he
of sunction. The maximum average value of turbulent energy is located at lower sunction, and a local high turbulent energy area also appeared at upper sunction. The simulated re
of a self-cleaning system indicate that the distribution of sunction tubes can not be uniform along the axial direction, and the position of sunction tubes can be adjusted and the nu
can be increased, which can increase the sunction power of lower sunction tubes and improve the cleaning efficiency of sediment.