Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 4, No. 7, July, 2018

Construction Network Ventilation System for Underground LPG Storage Cavern

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Received 28 May 2018; Accepted 21 June 2018

Abstract

Construction ventilation system is divided into two stages based on completion status of shafts in the underground petroleum storage project in Jinzhou, China. With the help of theoretical analysis and numerical simulations by using FLUENT software, in the first stage, reasonable construction ventilation is designed and cases with different outside temperature are discussed to investigate the effect of ventilation performance. It is found that with temperature difference increases, peak value of CO concentration, exhausting time of dirty air and required time to meet the CO concentration qualification decrease, but the influence degree is quite limited. Gallery-type network ventilation technique (GNVT) refined from theories of operation ventilation for road tunnel and mining ventilation network, is proposed to conduct the second stage construction ventilation. Ventilation performance of different ventilation schemes with various shafts' states and diverse arrangements of fans are also analyzed in this study. It turns out that Axial-GNVT with shafts taking in fresh air and access tunnel ejecting dirty air has much better performance than traditional forced ventilation from access tunnel. Improved energy saving scheme is finally adopted to guide the construction. In addition, it is worth mentioning that there is no need to build middle ventilation shafts and construct shafts as large and long as possible. Field test of wind speed, dust, poisonous gas, atmospheric pressure, temperature are performed to detect ventilation effectiveness. Reduction coefficient ξ_{bs} =0.69is obtained from the test results in consideration of super-large section and it also indicates that there is no difference if the axial fan is at the shaft mouth or in the bottom.

Keywords: Underground Petroleum Storage Caverns; Construction Ventilation System; Computational Fluid Dynamics; Ventilation Network.

1. Introduction

At present, water sealed underground petroleum storage caverns in rock, located in coastal regions where granite, welded stuff and other stable lithological rocks are widely distributed, is no doubt a project with better comprehensive economic effect and is also the main way used for strategic petroleum reserve [1-8]. It has been reported to have many advantages in construction cost, environmental protection, and operation safety [9-15]. Ventilation technique during the construction period in the large-scale underground engineering, related to construction conditions, cost and progress, still remains in exploration stage and there is no one systematic approach to solve this complex issue. Jurani [16] has discussed the main construction task for high-level nuclear waste disposal in a geologic repository and how ventilation design requirements were established and satisfied based upon current criteria. Rezaei et al. [17] have proposed and popularized reliability evaluation method of mine ventilation. Cornel et al. [18] have focused on multi cross tunnels in one underground coal mine project and performed ventilation network numerical simulation by using Canvent

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http://dx.doi.org/10.28991/cej-0309192