STUDI NUMERIK PERPINDAHAN KALOR PADA FUNNEL BERONGGA SILINDER

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ABSTRAK

Radiasi inframerah yang dihasilkan dari gas buang kapal menimbulkan risiko serius terhadap kesehatan manusia dan lingkungan, terutama akibat paparan suhu tinggi yang dapat memicu stres termal, kerusakan jaringan kulit, serta gangguan keselamatan kerja. Penelitian ini bertujuan untuk menganalisis perpindahan panas konveksi alami pada desain funnel berongga silinder dengan variasi panjang penampang, guna meningkatkan efisiensi sistem penekanan radiasi inframerah (*Infrared Suppression System*/IRS) pada kapal. Simulasi dilakukan menggunakan *Computational Fluid Dynamics* (Simscale) untuk memodelkan dan menganalisis variasi desain *funnel*, yang meliputi diameter lubang 0,20 m dengan panjang penampang 0,10 m, 0,20 m, dan 0,21 m, serta rentang suhu permukaan antara 375–750 K. *Funnel* variasi dengan panjang penampang 0,10 m menghasilkan nilai *Nusselt number* tertinggi (3116), *convective wall heat flux* tertinggi (29121 W/m²) dan *thermal radiation* tertinggi pada (4299 *W/m²*) pada suhu 750 K, menunjukkan perpindahan panas yang lebih cepat dibanding desain lain. Visualisasi kontur kecepatan aliran fluida mendukung temuan ini, di mana pola *buoyant plume* terbentuk lebih efektif, meningkatkan efisiensi pendinginan alami. Penelitian ini diharapkan dapat berkontribusi dalam pengembangan teknologi IRS yang lebih optimal, meningkatkan keselamatan awak kapal, serta menurunkan dampak radiasi inframerah terhadap lingkungan.

Kata kunci: Perpindahan Panas, *Natural Convection*, Funnel Berongga, IRS

NUMERICAL STUDY OF HEAT TRANSFER IN CYLINDRICAL HOLLOW FUNNELS

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ABSTRACT

Infrared radiation produced from ship exhaust gases poses a serious risk to human health and the environment, especially due to exposure to high temperatures that can trigger thermal stress, skin tissue damage, and occupational safety disturbances. This study aims to analyze the natural convection heat transfer in the design of a cylindrical hollow funnel with variations in the depth of the pipe cavity, in order to improve the efficiency of the Infrared Suppression System (IRS) on ships. Simulations were conducted using Computational Fluid Dynamics (Simscale) to model and analyze the variations in funnel design, which included a hole diameter of 0.20 m with cross-sectional lengths of 0.10 m, 0.20 m, and 0.21 m, as well as a surface temperature range between 375–750 K. Funnel variations with a cross-sectional length of 0.10 m resulted in the highest Nusselt number values (3116), the highest convective wall heat flux (29121 W/m²), and the highest thermal radiation at (4299 W/m²) at 750 K, indicating faster heat transfer than other designs. Visualization of fluid flow speed contours supports these findings, where buoyant plume patterns are formed more effectively, improving natural cooling efficiency. This research is expected to contribute to the development of more optimal IRS technology, improve crew safety, and reduce the impact of infrared radiation on the environment.

***Keywords**: Heat Transfer, Natural Convection, Hollow Funnel, IRS*