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**STUDI NUMERIK PENGARUH CROSSECTIONAL AREA PADA PRESSURE DUCT DAN PLENUM SERTA MATERIAL SUPPLY DUCT
TERHADAP KENYAMANAN PENUMPANG KERETA CEPAT MERAH PUTIH (KCMP)**
Samsul Ma'arip, Ir. Fauzun, S.T., M.T., Ph.D., IPM., ASEAN Eng.
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INTISARI

Peningkatan mobilitas penduduk dan pengembangan Kereta Cepat Merah Putih (KCMP) menuntut sistem pengendalian tekanan dan pengkondisian udara yang mampu menjamin kenyamanan aural dan termal penumpang. Fluktuasi tekanan akibat fenomena aerodinamika berpotensi menimbulkan ketidaknyamanan aural, sementara distribusi temperatur dan kecepatan udara memengaruhi kenyamanan termal dalam kabin. Penelitian ini bertujuan menganalisis pengaruh *variasi cross-sectional area pressure duct* dan *plenum* terhadap distribusi tekanan dan kecepatan udara, serta mengevaluasi pengaruh material insulasi *supply duct* dan sistem pengkondisian tekanan terhadap distribusi temperatur dalam kabin KCMP.

Penelitian ini menggunakan simulasi numerik tiga dimensi berbasis Computational Fluid Dynamics (CFD) dengan ANSYS Fluent 2025. Domain simulasi mencakup kabin, *pressure duct*, *supply duct*, *return duct*, dan *plenum*, tanpa melibatkan model terowongan agar analisis lebih efisien dan terfokus pada fenomena di dalam kabin. Variabel bebas yang dikaji meliputi variasi luas penampang *pressure duct*, luas penampang *plenum*, serta material insulasi *supply duct*. Sementara itu, variabel terikat yang dianalisis mencakup distribusi tekanan, kecepatan udara, dan temperatur kabin.

Hasil simulasi menunjukkan bahwa variasi luas penampang *pressure duct* dan *plenum* berpengaruh terhadap kestabilan tekanan serta keseragaman distribusi kecepatan udara di dalam kabin. Dimensi terbaik diperoleh pada *pressure duct* adalah 150 × 50 mm dan *plenum* 1250 × 960 mm karena mampu menghasilkan perubahan tekanan yang lebih rendah dengan distribusi aliran yang lebih stabil. Sementara itu, material insulasi *supply duct* turut memengaruhi distribusi temperatur kabin. Dari variasi yang diuji, EVA foam 10 mm dipilih sebagai material terbaik karena memberikan performa termal paling baik. Secara keseluruhan, sistem pengkondisian tekanan berbasis *fan* dan *ducting* terbukti berperan penting dalam menjaga kestabilan tekanan kabin sekaligus memengaruhi gradien temperatur dan kecepatan dalam kabin.

Kata kunci: CFD, *pressure duct*, *plenum*, kenyamanan aural, kenyamanan termal, KCMP.

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ABSTRACT

The increasing mobility demand and the development of the *Kereta Cepat Merah Putih* (KCMP) require a cabin pressure control and air-conditioning system capable of ensuring both aural and thermal passenger comfort. Pressure fluctuations caused by aerodynamic phenomena may lead to ear discomfort, while air temperature and velocity distribution affect thermal comfort inside the cabin. This study aims to analyze the effect of cross-sectional area variations of the pressure duct and plenum on pressure and airflow velocity distribution, as well as to evaluate the influence of supply duct insulation materials and the pressure control system on cabin temperature distribution in KCMP.

A three-dimensional numerical simulation based on Computational Fluid Dynamics (CFD) was conducted using ANSYS Fluent 2025. The simulation domain includes the cabin, pressure duct, supply duct, return duct, and plenum, without incorporating a tunnel model, in order to enhance computational efficiency and focus on internal cabin pressure phenomena. The independent variables consist of variations in pressure duct and plenum cross-sectional areas as well as supply duct insulation materials, while the dependent variables include cabin pressure distribution, air velocity, and temperature.

The simulation results show that variations in the cross-sectional area of the pressure duct and plenum significantly affect pressure stability and the uniformity of air velocity distribution inside the cabin. The best dimensions were obtained with a 150 × 50 mm pressure duct and a 1250 × 960 mm plenum, as these configurations produced lower pressure changes and a more stable airflow distribution. Meanwhile, the supply duct insulation material also influenced the cabin temperature distribution. Among the tested variations, 10 mm EVA foam was selected as the best material because it provided the most favorable thermal comfort. Overall, the fan and ducting-based pressure conditioning system proved to play an important role in maintaining cabin pressure stability while also affecting the temperature gradient between cabin sections.

Keywords: CFD, pressure duct, plenum, aural comfort, thermal comfort, KCMP.