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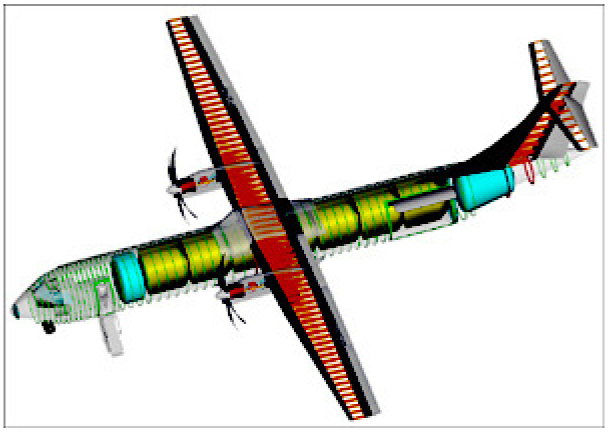
New Study Examines Regional & Intercontinental H2-Fueled Transport Planes

HAMBURG/BRAUNSCHWEIG, GERMANY – Airlines, manufacturers and research institutions, faced with escalating fuel prices and emission constraints, are looking again at hydrogen as fuel for big transport planes.



An image of the ATR72 liquid hydrogen-fueled regional freighter. The two containers at each end, in between the freight containers, represent the hydrogen tanks.

One of the latest examples of this interest is the German "Green Freighter" study, picking up where the German Airbus "Cryoplane" research project of the 1990s (The Hydrogen Letter, April 89, H&FCL Aug. 00), the Russian Tupolev TU-155 passenger jet which actually flew in the 1980s (The Hydrogen Letter Oct. 88, Aug. 94), and earlier studies by Lockheed in the 1970s left off.

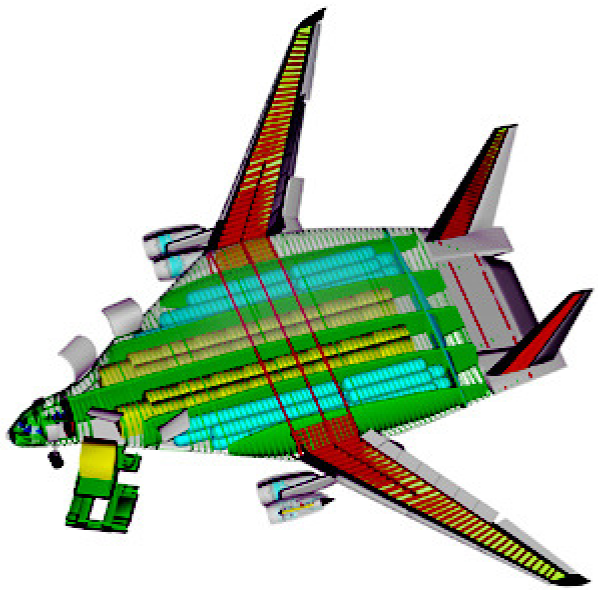
As far as is known, there are no current plans to actually build any hydrogen-fueled transport aircraft.

A paper on the four-year study, "Hydrogen Powered Freighter Aircraft – The Final Results of the Green Freighter Project," is scheduled to be presented at the 27th International Congress of the Aeronautical Sciences in September in Nice, France. Participating in the 2006-2010 study were researchers at the Hamburg University of Applied Sciences; Braunschweig Technical University; Airbus; and Bishop GmbH Aeronautical Engineers, Hamburg (More details are on the Green Freighter website, http://GF.ProfScholz.de). The study was partly financed by the German Education and Research Ministry.

Turboprop, Blended-Wing Future Transport

The project studied two types of aircraft. One is a hydrogen version of the twin-turboprop ATR 72 regional freighter built and sold in many parts of the world by its Toulouse-based manufacturer, Avions de Transport Regional, similar to the earlier, smaller German Dornier DO-328 which at one point had been considered a candidate for conversion to hydrogen (The Hydrogen Letter, Jan. 97). The other is a futuristic blended-wing body airplane that exists only as a design study.

The three principal researchers, Kolja Seeckt and Dieter Scholz in Hamburg and Wolfgang Heinze in Braunschweig, decided to look at air freighters instead of passenger planes because air cargo traffic is forecast by both Airbus and Boeing to grow somewhat faster in the next 20 years than airline traffic: 5.2% annually and 5.4%, respectively, by Airbus and by Boeing for cargo, and 4.7% and 4.9% for airline traffic.



A rendering of the blended-wing-body hydrogen-fueled long-distance cargo plane concept. Fifty cylindrical hydrogen tanks are arranged in long rows on the upper and lower decks.

Also, the investigators believe that looking at freight traffic first would be easier and more practical because air cargo transport is limited to a relatively small number of airports, making the needed infrastructure changes simpler. Also, the psychological acceptance of these new aircraft is expected to be easier with a cargo version than with a passenger plane.

Basically, analysis of the smaller regional ATR hydrogen freighter found that it would have about a 5% smaller takeoff weight of 22 tons, including an 8 ton payload, and consume about 10% less energy than the operational kerosene-fueled version, despite the fact that when empty, the plane would weigh about 7% more.

Technical Advantages, No Better Economics

Calculations for a four-engined blended-wing-body long-range freighter of roughly the same size and payload capability – 108 tons - as the twin-jet Boeing B777F operating on liquid hydrogen showed potential savings of 7

% in takeoff weight, mostly because of weight savings of almost two-thirds compared to a kerosene version. The hydrogen BWB plane would have a takeoff weight of 310 tons, or about 7% less than a hypothetical kerosene version, and the plane would burn 33 tons of hydrogen for the design range of 4,779 nautical miles (5,500 miles),

Aside from the main benefit of producing very little or no carbon dioxide emissions and the presumably much reduced dependence on fuel from oil-exporting nations, the study again confirmed liquid hydrogen's big technical advantage of much lower maximum take-off weight, crucial in aviation, compared to kerosene - a big consideration why Lockheed, Tupolev and Airbus were interested in hydrogen. But there are also important disadvantages: it's expensive to produce, and as liquid cryogenic hydrogen it is about four times as voluminous as kerosene for the same amount of energy – all of which means a hydrogen fuel system would be very heavy because of the large tanks and thick thermal insulation.

Among the major conclusions, the researchers say the lower take-off weights translate into take-off runs between 14% and 28% shorter than with the kerosene versions. But these technical advantages do not translate into economic benefits assuming the cost of both fuels in the future will be equivalent in terms of energy content: the hydrogen plane is expected to have 15% higher direct operating costs because of their higher empty weights.

Lower Take-Off, Landing Weights

Also, various versions of the regional hydrogen freighter have lower maximum take-off and landing weights because of their "significantly" smaller fuel loads, translating into about 10% lower energy consumption, the study concludes. In the case of the blended wing body plane, design analyses show a potential for weight savings of 7 % to 9 % for what could be an unmanned freight plane over the comparable Boeing B777F. However, the hydrogen BWB version does not exhibit any clear superiority over the conventional fuselage-and-wings configuration, mostly because of the low wing loading which is the result of the needed minimum size and the low hydrogen weight; put another way, the BWB cannot take advantage of its inherent aerodynamic superiority during cruise flight because it weighs too little. However, the researchers say this would lose its importance with bigger planes with bigger payloads of more than 150 tons that may be designed and built in the future. *Contact: Kolja Seeckt, kolja.seeckt@haw-hamburg.de.*