

Instytut Lotnictwa, Warszawa

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Streszczenie rozprawy doktorskiej

Temat pracy: „Weryfikacja formuł matematycznych opisujących proces ruchu kropeł rozprzestrzenianych ze statku powietrznego”

Obszar i dziedzina nauk technicznych

Dyscyplina: budowa i eksploatacja maszyn

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Abstract:

As a part of the contemporary fight against harmful organisms attacking forests and agricultural crops in many areas of the globe, pesticides or other water-soluble agents are applied. They are applied in the form of small drops spraying, that settle mainly due to gravity force. The dissertation is focused on the spraying from the air using aircraft, above all, helicopters and planes. Recently, there has been a strong increase in the use of unmanned aerial vehicles as well. The use of such techniques, however, is associated with a strong migration of sprayed material from the areas subjected to treatments over the surrounding areas, especially when the treatments are carried out improperly. It may cause contamination of unintended areas.

Therefore, an attempt to model the process of spraying and settling the liquid drops in the lower atmosphere of the Earth was made. After sketching and analyzing selected ideas and models of previous authors, one could notice a very strong simplification in the description of aerodynamic wakes left by the flying aircraft (especially in very close vicinity of the ground). This seems to be a significantly wrong assumption. Drops are introduced into the atmosphere from atomizers located just below the airfoil or in the middle part of the aircraft. Therefore, the velocity field generated by aircraft in flight has the greatest impact on their movement.

Wind and its atmospheric turbulence is the second, most important factor, especially in cases of vertical air movements. Nonetheless, the agricultural treatments are being carried out in the best weather conditions, thereby eliminating their potential influence. However, it is not possible to eliminate the very strong and unavoidable aerodynamic trace.

Hence, the need to pay attention to the nearest wake of the plane, which can not be modeled using only two vortex lines, as in the most previous models, is very urgent. Most, if not all the existing works, do not take into account the full, three-dimensional aircraft models, including fuselage, gears, struts, elevators or rudders. Only the influence of wings, propellers or rotors, in the form of vortex lines, on the aircraft velocity fields, was modeled. Thus, the main axis of work has been put on the creation of the full, 3D models of both the helicopter and the airplane. The Mi-2 helicopter and the PZL-106

“Turbo Kruk” plane were selected. Analyses were carried out using CFD methods for a side wind and for the windless air as well as for the fully loaded plane and the plane in the final spraying stage, with the minimum level of fuel and chemicals. Lateral distributions of droplets on the ground was obtained, which was then compared to experimental data and to the solutions done by the selected models of other authors for the helicopter, while for the plane the results were compared only to the results obtained by means of other models.