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THE CRITERION OF CHOOSING THE PROPER SEEDING PARTICLES

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Abstrakt: *This paper is focused on the problem of the ability of seeding particles to follow the flow field. One of the most important factors influencing the resultant accuracy of the measurement is using the proper seeding particles for feeding the flow when measuring by Particle Image Velocimetry method – PIV. The aim of the paper is to provide comprehensible instruction for choosing the proper type of seeding particles with regard to the flow characteristics and required measurement accuracy. The paper presents two methods with the help of which it is possible to determine the seeding particles' ability to follow the flow field. The first method is based on the direct calculation of the phase lag and amplitude ratio between the particle and the fluid. The calculation is based on solution of the BBO equation for spherical particle. The other method results from the calculation of the particle time response, which defines the maximum frequency of disturbances, which are to be followed by the particle. In the conclusion, the method of choosing the seeding particles is proposed, depending on the required measurement accuracy.*

Keywords: ***PIV, seeding particles, BBO, accuracy***

This paper is focused on the problem of the ability of seeding particles to follow the flow field. One of the most important factors influencing the resultant accuracy of the measurement is using the proper seeding particles for feeding the flow when measuring by Particle Image Velocimetry method – PIV.
The aim of the paper is to provide comprehensible instruction for choosing the proper type of seeding particles with regard to the flow characteristics and required measurement accuracy. The paper presents two methods with the help of which it is possible to determine the seeding particles' ability to follow the flow field.
The first method is based on the direct calculation of the phase lag and amplitude ratio between the particle and the fluid. The calculation is based on solution of the BBO equation for spherical particle.

The given equation is valid for these cases:

- The size of the smallest vortices is several times bigger than the particle diameter;
- The Reynold's number calculated from the particle diameter and from the difference between liquid and particle velocity is lower than 1.
- The particles density in the liquid has to be low enough in order to prevent from interaction among the individual particles as well as to prevent the particles features from changing during the process of adding the particles to the fluid;
- The turbulence is homogeneous.

The other method results from the calculation of the particle time response, which defines the maximum frequency of disturbances, which are to be followed by the particle.
Based on the presented approaches it is possible to determine the maximum frequency of disturbances that can be followed by the concrete particles. The comparison of both methods is summarized in table 1 which contains the response times of individual particles as well as maximum frequencies based on BBO equation solution and based on the time response calculation. The comparison of both methods shows full correspondence between both approaches. From the results it is evident that if specific gravity of the particle and fluid approaches one, the maximum frequencies calculated by means of BBO equation are higher than the values determined by means of time response. On the contrary, at higher specific gravity the maximum frequency calculated by means of BBO equation is lower than value determined from time response. This behavior is given by the fact that the influence of particular

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BBO equation terms changes with changing particle and fluid density ratio. The measurement by the PIV method makes also use of different particles than those presented in table 1 with their maximum frequencies which is the reason why the paper proposes the method, for given particle type and given fluid, with the help of which it is possible to easily and quickly determine the frequency to be followed by the particles with chosen accuracy.

Tab. 1: Parametres of particles used for measuring by the PIV method

Particles used for measuring in liquids Dynamic viscosity of water at 20 °C 1.002 10-3 [kgm-1s-1]				
Material of particle Density[kgm-3]	Polyamide 1030	Glass particles 1100 [kgm-3]	Silvered glass particles 1400 [kgm-3]	Fluorescent particles 1500 [kgm-3]
Diameter [μm]	5 10 20	5 10 20	5 10 20	10 30 75
Response time of particle τv [μs]	1.42 5.71 22.84	1.5 6.10 24.4	1.9 7.76 31	8.32 74.850 467.81
fMAX - BBO	>100 kHz 79 kHz 18 Hz	50 kHz 11 kHz 2.6kHz	12 kHz 2.8 kHz 850 Hz	2.3 kHz 250 Hz 45 Hz
fMAX – τv	25 kHz 6.2 kHz 1.5 kHz	23 kHz 5.8 kHz 1.4 kHz	18 kHz 4.6 kHz 1.1 kHz	4.3 kHz 470 Hz 75 Hz

Particles used for measuring in liquids Dynamic viscosity of water at 20 °C 1.71 10-5 [kgm-1s-1]				
Material of particle Density [kgm-3]	Oil 800	Water 1000	Aluminium powder 2700	Polystyrene microballs 30
Diameter [μm]	1 1.5 3	1 1.5 3	0.3	40 100
Response time of particle τ [μs]	2.60 5.85 23.40	3.25 7.31 29.24	0.79	155.95 714.75
fMAX - BBO	7 kHz 3.2 kHz 810 Hz	6 kHz 2.7 kHz 700 Hz	25 kHz	85 Hz 15 Hz
fMAX – τv	13.6 kHz 6 kHz 1.5 kHz	10.8 kHz 4.8 kHz 1.2 kHz	44.8 kHz	226 Hz 50 Hz