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INFLUENCE OF THE GEOMETRY DESIGN OF THE RIGID PITOT TUBE ENTRY ON THE TOTAL HEAD OF THE PITOT TUBE PUMP

Geometry design

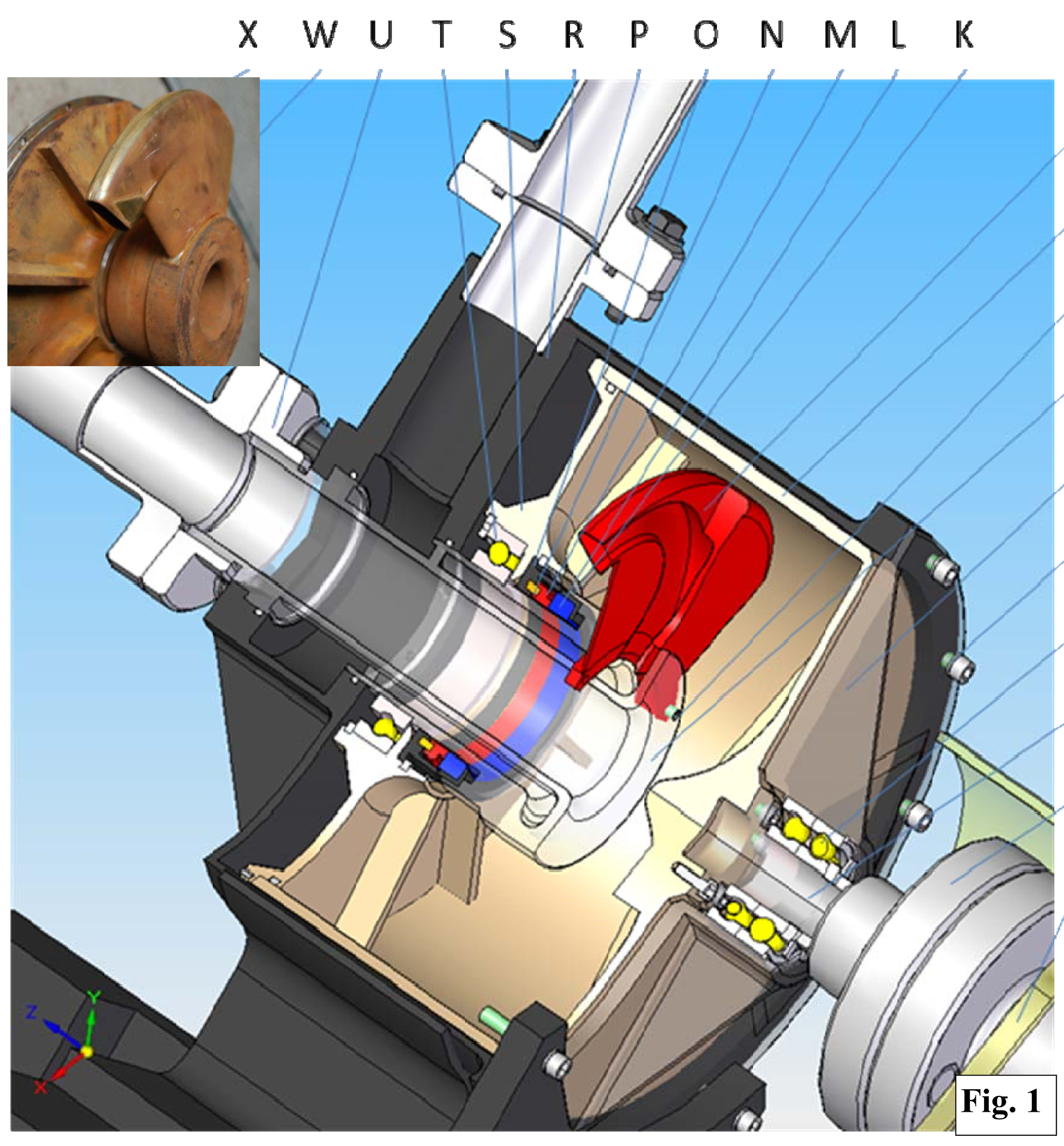


Fig. 1

Represented pump has nominal parameters as follows:

- Specific speed $n_q = 5{,}28$
- Total Head $H_n = 148$ m
- Capacity $Q_n = 15$ m^3/h
- Efficiency $\eta_n = 33$ %
- Power Consumption $Pw_n = 18$ kW

Stage 1

Research contained 16 types of pick-up inlets into pitot tube models. Selected geometry parameters are demonstrated on the table 1 and in fig. 2 ÷ 4.

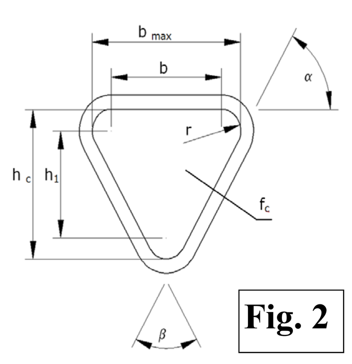


Fig. 2

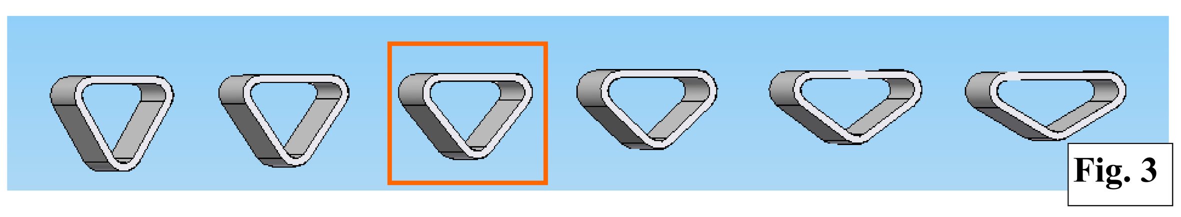


Fig. 3

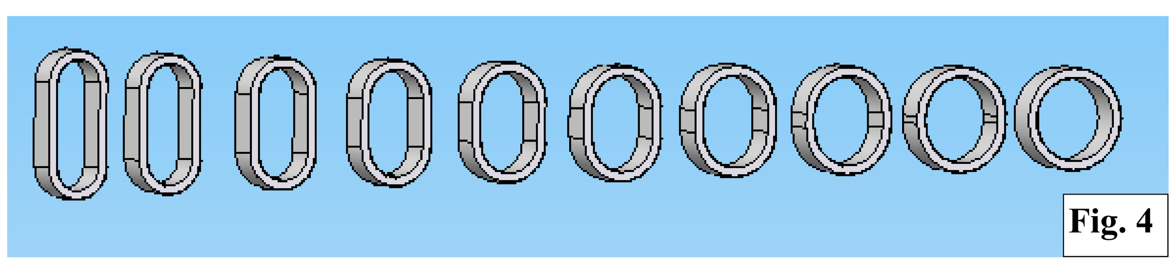


Fig. 4

L.p.	Oznaczenie modelu czer-paka	b_{max} mm	h_c mm	h_1 mm	b mm	r mm	α °	β °	b_{max}/B -	b_{max}/l_p -
1.	cz. A	37,56	13,94	7,94	27,56	3	30	120	0,235	0,1639
2.	cz. B	35,46	15,2	9,2	25,46	3	36	108	0,222	0,1548
3.	cz. C	32,1	16,74	9,74	21,1	3	42,5	95	0,201	0,1401
4.	cz. D	30,31	18,37	12,37	20,31	3	50,5	79	0,189	0,1323
5.	cz. E	29,18	19,91	14,51	19,78	3	55,5	69	0,182	0,1274
6.	cz. F	27,31	20,99	17,31	14,99	3	60	60	0,171	0,1192

Stage 2

In the case of stage 2 central radial passage and axial-radial pitot tube passage were changed. Four small walls (Y) forming four pipes were removed leaving one canal, (l=50 mm long round discharge cylinder (Fig. 7)).

All (circle-oval and triangle) the axial passage diffusers of pitot tube were connected at right angle to discharge cylinder.

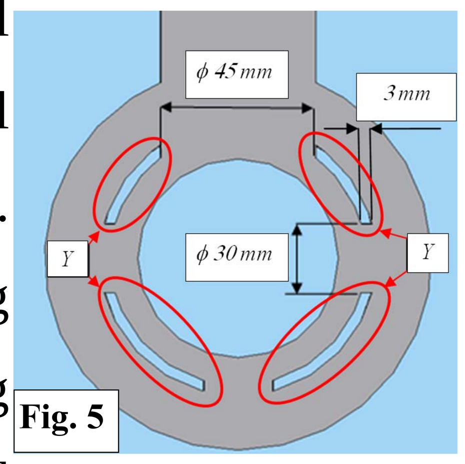


Fig. 5

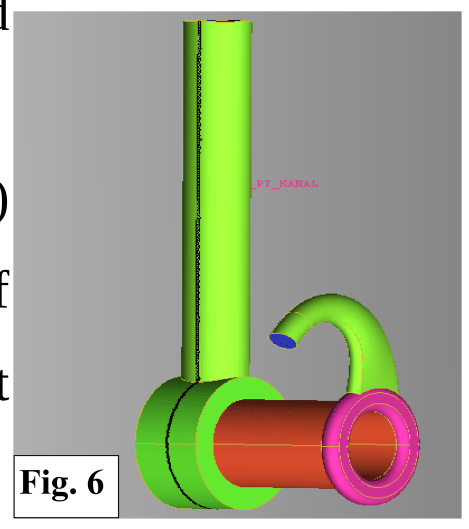


Fig. 6

Turbulence modeling

The complete formulation of Shear Stress Transport (SST) is described by equations (1), (2) and (3)

- Turbulent Kinetic Energy

$$\rho\frac{\partial\omega}{\partial t}+\rho u^i\frac{\partial\omega}{\partial x^i}=\frac{\partial}{\partial x^j}\left(\left(\mu+\frac{\mu_t}{\sigma_\omega}\right)\frac{\partial\omega}{\partial x^j}\right)+G_\omega-Y_\omega+D_\omega \quad (1)$$

- Specific Dissipation Rate

$$\rho\frac{\partial k}{\partial t}+\rho u^i\frac{\partial k}{\partial x^i}=\frac{\partial}{\partial x^j}\left(\left(\mu+\frac{\mu_t}{\sigma_k}\right)\frac{\partial k}{\partial x^j}\right)+G_k-Y_k \quad (2)$$

- Eddy Viscosity

$$\mu_t=\rho\frac{k}{\omega} \quad (3)$$

where:

G_k and G_ω represent the generation of k and ω

Y_k oraz Y_ω represent the dissipation of k and ω

D_ω is the cross-diffusion term

Descritization model is presented below:

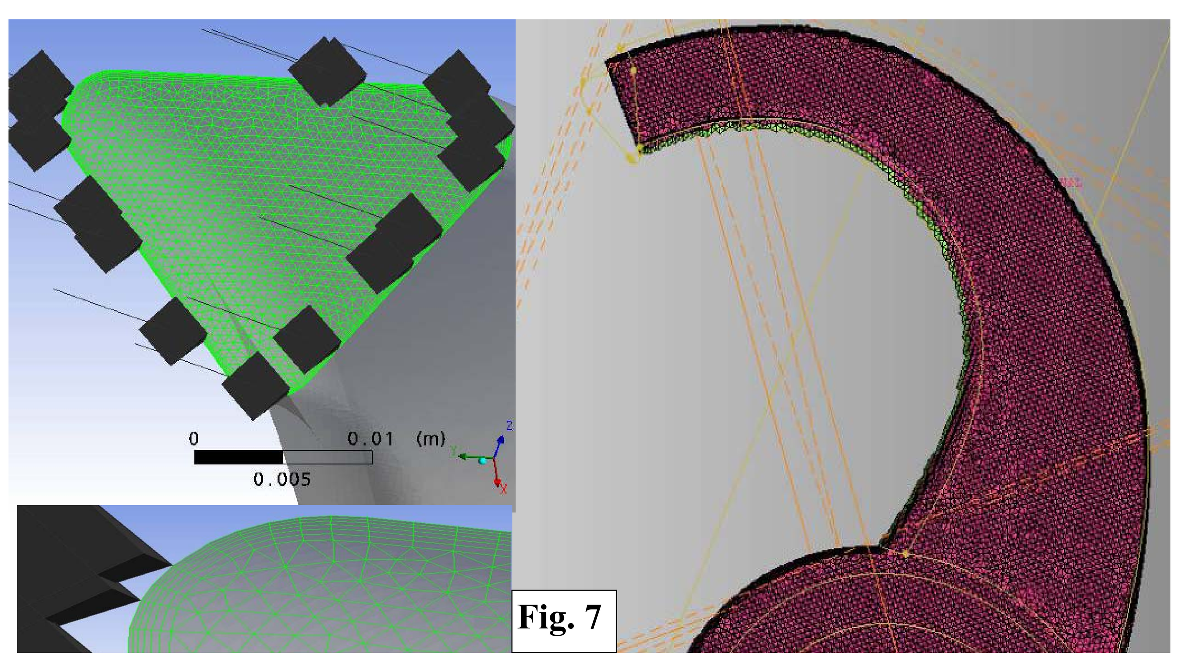


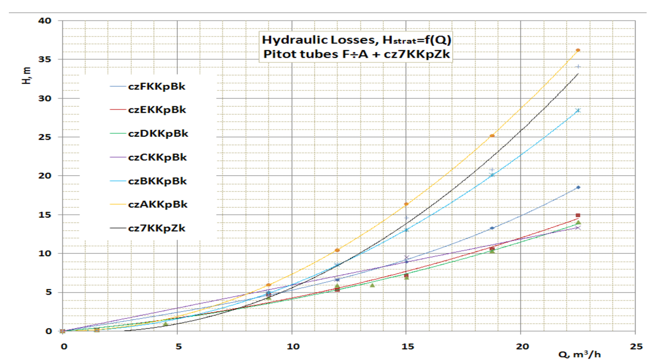
Fig. 7

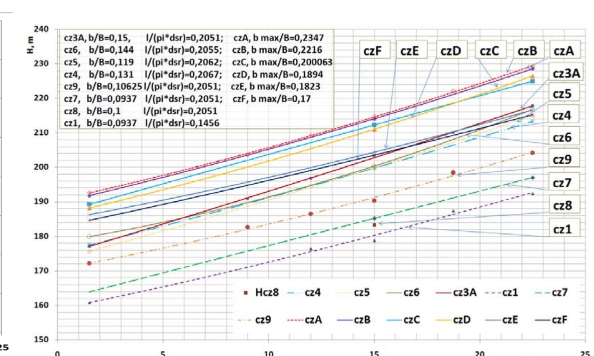
Results

As the result of proper CFD modeling the highets net total head by $Q/Q_n=1$ was obtained for cz.A, $H_{cz.A}=214{,}74$ m (cz.A÷F) as well as cz.3A (cz.1÷9) $H_{cz.3A}=203{,}31$ m.

L.p	model	Q/Qn=0,1 H_{wlot}, m	$H_{str\,K}$, m	H_{wynik}, m	Q/Qn=1 H_{wlot}, m	$H_{str\,K}$, m	H_{wynik}, m	Q/Qn=1,5 H_{wlot}, m	$H_{str\,K}$, m	H_{wynik}, m
1.	czF	184,520	0,163	184,357	203,440	8,970	194,470	215,150	18,555	196,595
2.	czE	186,220	0,145	186,075	204,330	7,165	197,165	216,590	14,945	201,645
3.	czD	188,200	0,136	188,064	210,980	6,928	204,052	226,430	14,056	212,374
4.	czC	189,240	0,000	189,240	212,220	9,478	202,742	224,900	13,297	211,603
5.	czB	191,720	0,144	191,576	214,020	13,065	200,955	228,530	28,454	200,076
6.	czA	192,630	0,164	192,466	214,760	16,400	198,360	229,150	36,222	192,928
7.	cz3A	177,050	0,152	176,898	203,310	9,580	193,730	217,740	15,057	202,683
8.	cz6	179,850	0,112	179,738	200,280	9,511	190,769	216,680	12,070	204,610
9.	cz4	177,420	0,161	177,259	199,720	10,913	188,807	213,250	15,924	197,326
10.	cz5	175,580	0,000	175,580	199,840	11,825	188,015	214,880	17,636	197,244
11.	cz9	172,100	0,000	172,100	191,280	14,949	176,331	204,130	20,222	183,908
12.	cz7	170,100	0,158	169,942	185,120	12,030	173,090	196,960	27,086	169,874

After doing the research of all radial passage pitot tube by $Q/Q_n=1$ were noticed for cz.DKKpBk; $\Delta H_{cz.DKKpBk}=6{,}928$ m and cz.3A; $\Delta H_{cz.3AKKpBk}=9{,}58$ m.





Taking into consideration the recieved results the most appriopriate models are cz.D with cz.DKKpBk total head equals $H_{cz.D}=204{,}052$ m, and second model cz.3A with cz.3AKKpBk achieving total head amount to $H_{cz.3A}=193{,}73$ m.

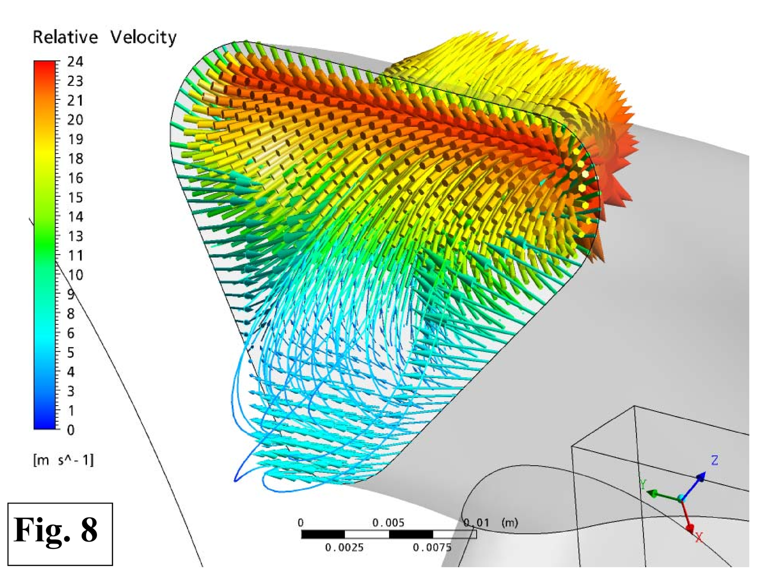


Fig. 8

All the research models were made simpler therefore it is necessary to carry out two pitot tubes in the physical models and do tests on the nominal parameters.

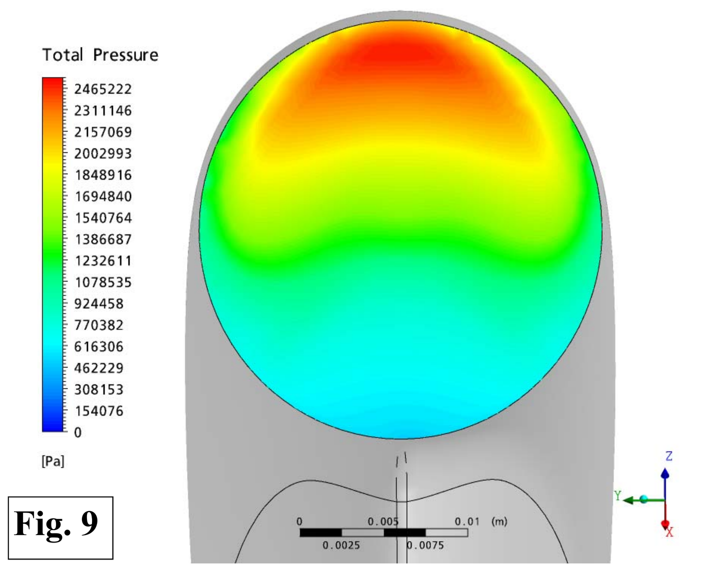


Fig. 9

It is necessary to make all elements from noble metals due to durability.

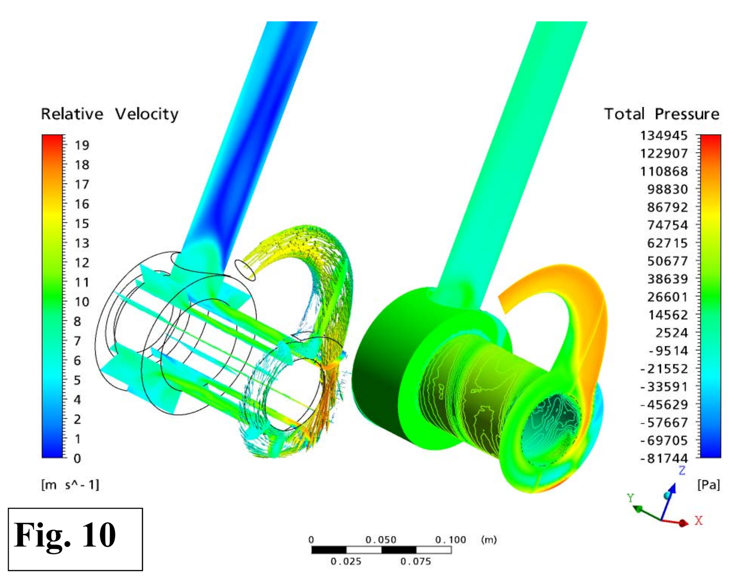


Fig. 10