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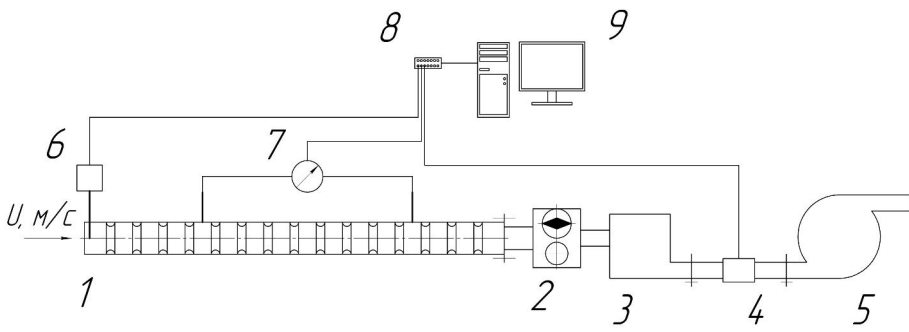
(13-08-00504, 14-01-31067),
(16.518.11.7015, 02.740.11.0071) 0217-2014-0001

2014 .), VII IX (2011 - « -
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 . . , T. Mizushina, T. Maruyama, H. Hirasawa, M.Y. Gündo du, -
 M.Ö. Carpinlio lu). -
 . . , . . , -
 . . () -
 . , 60 %, -
 - . -
 (), -
 , -
 . -
 f = 0,2 - 5 (Sh -
). , -
 , (Re, -
), -
 Sh = 0 - 0,1. Sh -

(0,02)

Sh



1.

1 -

2.

3,

« - 4- » 4,

5.

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» 7.

« -5.1»

6

9

() 8

«L - CARD - 791».

(2),

1

2,

3

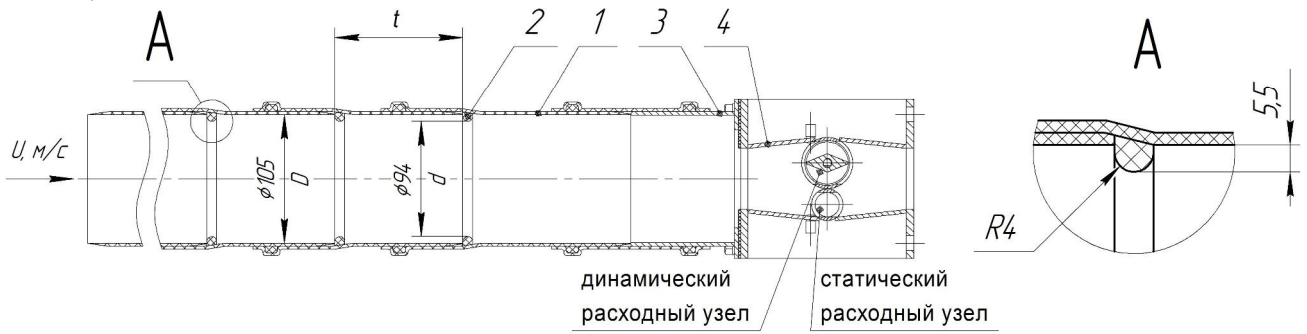
4.

u

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2.

A_u



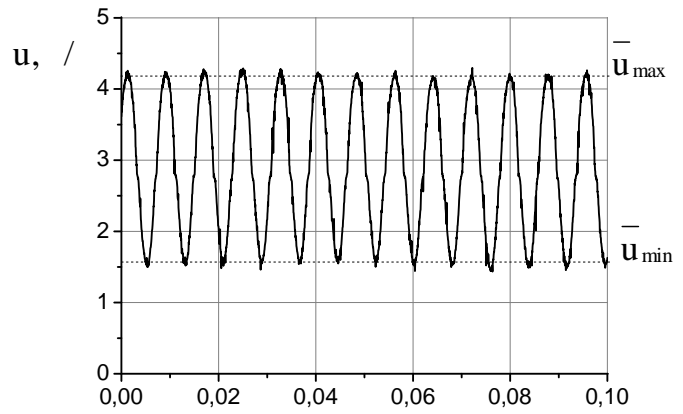
2 -

$$u = \bar{u} (1 + \beta \sin(2\pi f t + \dots))$$

(1)

$$\beta = \frac{\bar{u}_{\max} - \bar{u}_{\min}}{\bar{u}_{\max} + \bar{u}_{\min}}$$

(2)



3 -

$$\bar{u} = 2,91 / , f = 127$$

3.

Sh,

$$0,055 \cdot 2,$$

$$\frac{10}{D}$$

() .

4.

4

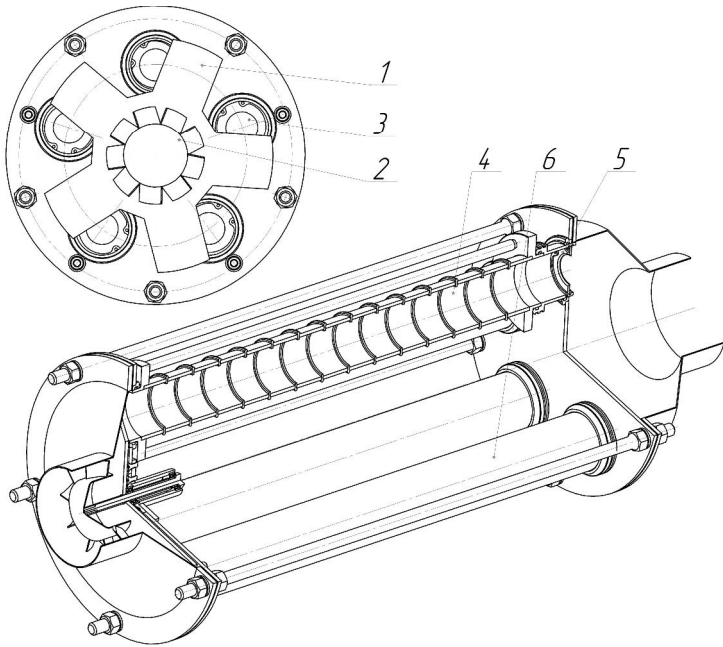
6 -

() 2,

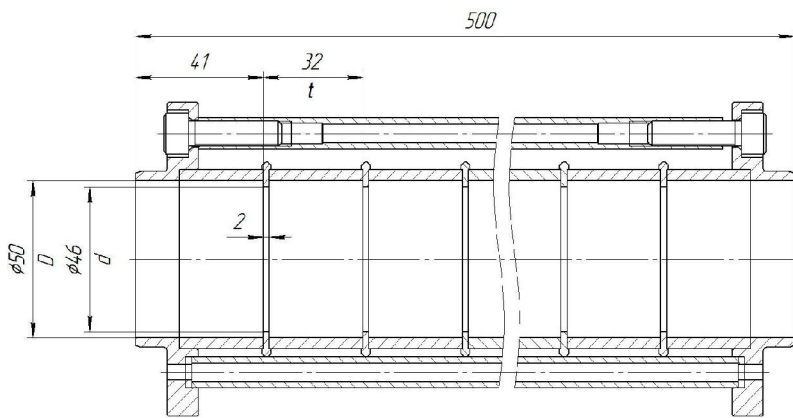
1,

3

2 3



4 -



5 -

4

5
 $d = 30$

(5).

(

30 - 50°

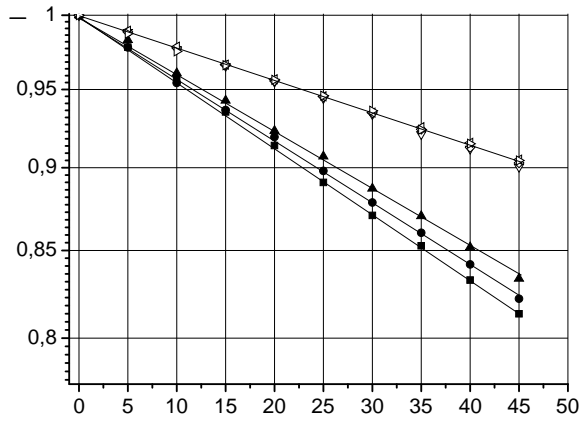
200

45

, / (2),

$$\alpha_i = \frac{\ln(\frac{V_i}{F_i})}{\Delta} \quad (3)$$

$$T_{ij} = T_{i0} - \alpha_i (T_{j0} - T_{i0})$$



6 -
 : ∇ -170 , Δ -220 ,
 $< -265 , > -320$
 : -150 , -245 , -345

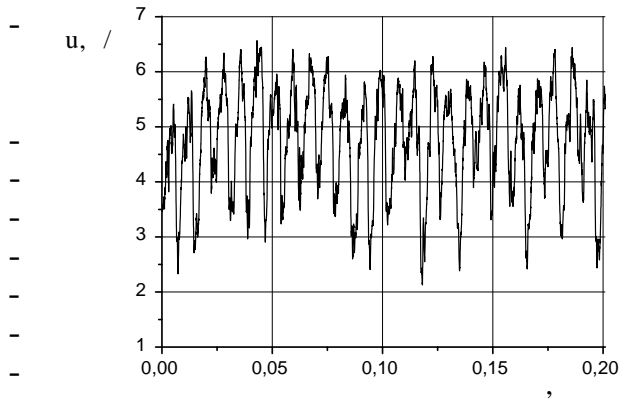
196 3/

6.

0,45

7).

(



7 -

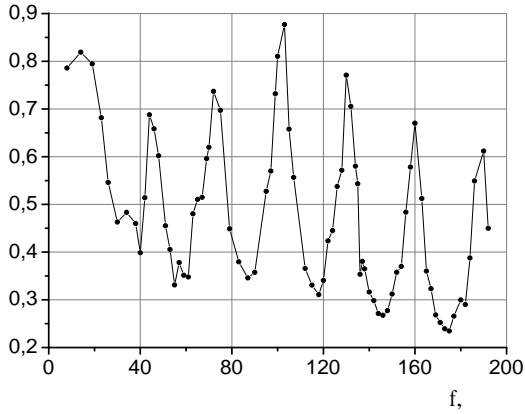
$$\bar{u} = 5 / ,$$

$$f = 126$$

$$\overline{Nu} = Nu/Nu , \quad Nu$$

Nu -

\overline{Nu}



$$\left(\bar{u}_1 + \overline{u_1^2} \right) - \left(\bar{u}_2 + \overline{u_2^2} \right) = \frac{\Delta L}{D} \frac{(\bar{u})^2}{2}, \quad (4)$$

$$\bar{u}, \overline{u^2} -$$

(
); L -

8 -

$$= \frac{f \left(\bar{u}_1 + \overline{u_1^2} \right) - \left(\bar{u}_2 + \overline{u_2^2} \right)}{\Delta L \overline{u^2} / (2D)}. \quad (5)$$

$$\bar{u}_1^2 = \bar{u}_2^2.$$

L = 6

D = 0,105 .

3,5
f = 7 - 190 .

f 8.

$$f = \frac{c}{4L} i, \quad (6)$$

-, / ; i - 3, 5, 7,

\bar{u}

(9,).

9 ,

$$\bar{u}_1^2 = \bar{u}_2^2$$

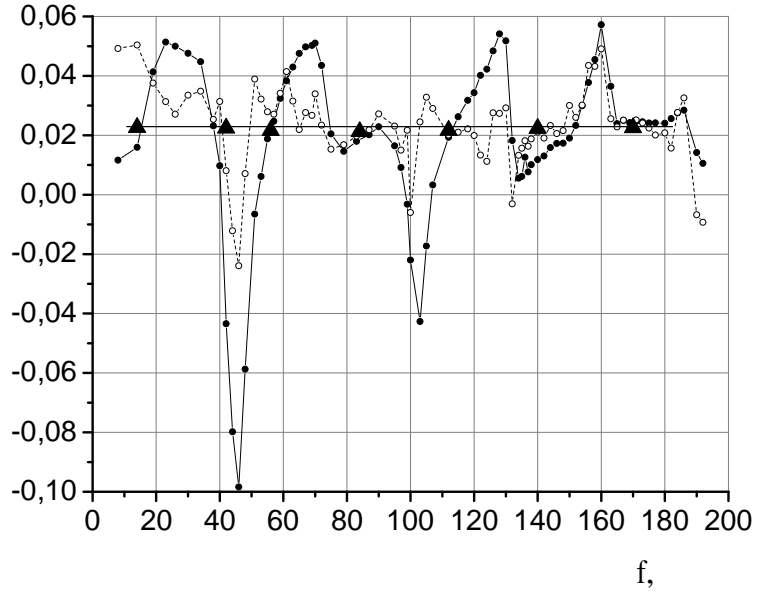
$$\bar{u}_1^2 = \bar{u}_2^2$$

\bar{u}^2

(,

)

().



9 -

$$\overline{u_1^2} = \overline{u_2^2}; \quad (7)$$

f

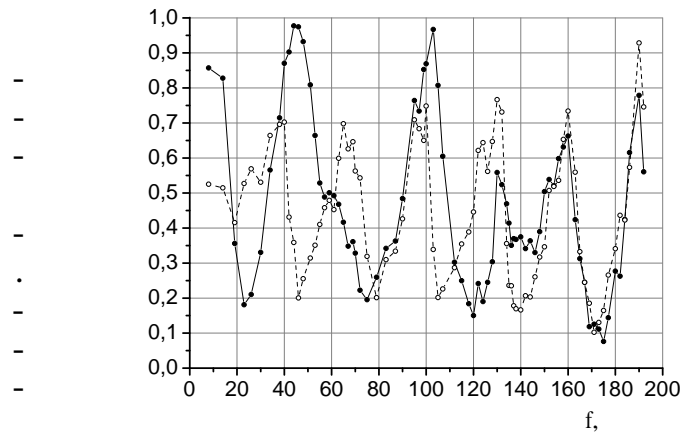
10.

f = 46

(9,).

$$\overline{u_1^2} > \overline{u_2^2},$$

$$\overline{u_1^2} = \overline{u_2^2}$$



10 -

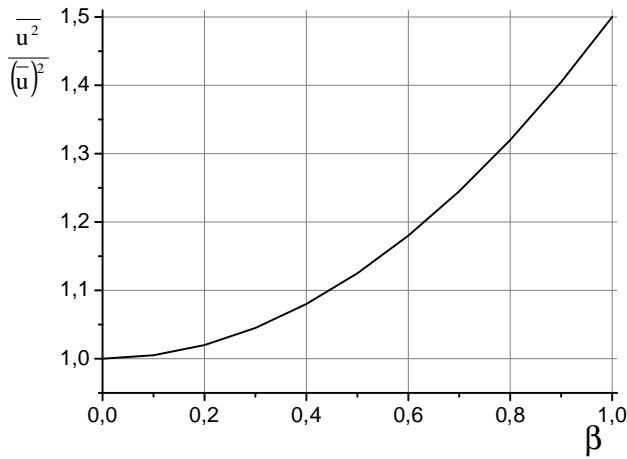
f

1; 2.

(

$\overline{u^2}$

10)



$$= \frac{\Delta + (\bar{u})^2 (k_1 - k_2)}{\Delta L (\bar{u})^2 / (2D)}, \quad (7)$$

$$k = \overline{(u_1^2)} / (\bar{u})^2 -$$

$(\bar{u})^2$.

k

11 -

$\overline{(u_1^2)}$

$$\overline{(u_1^2)} = \frac{T}{T_0} \int_0^T (1 + \sin(2\pi f t))^2 dt \cdot (8)$$

T

$\overline{(u_1^2)} / (\bar{u})^2$

(7)

(8)

11.

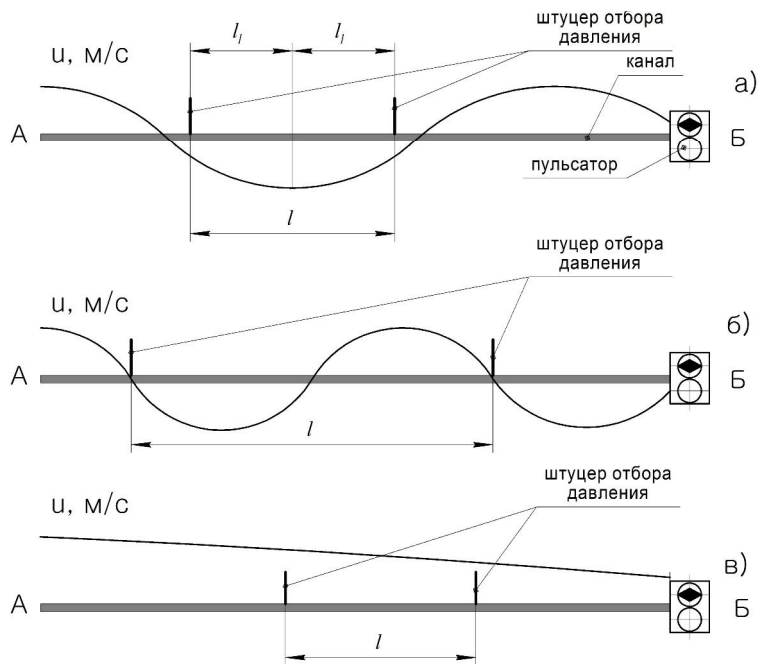
9 (

).

9,

$\overline{u^2}$

12



(12,)

12 -

(

12,).

($\gg L$),

(12,).

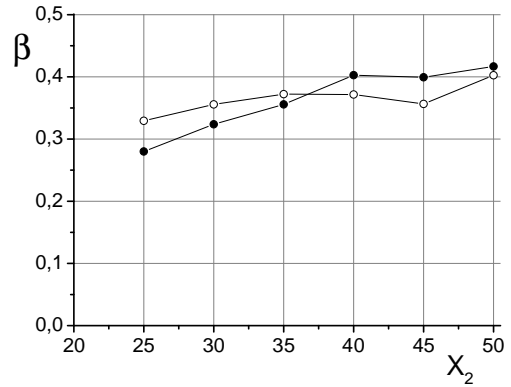
1 2

$$\overline{(u^2)} \quad (\bar{u})^2$$

9,)

$$\text{Sh} = 0,01 - 3, \\ = A_U/\bar{u} = 0,2 - 0,7.$$

Re=11000-41000,



beta

(8, 10).

t/D = 1

13 -

f = 100

1 = 30

2610

30

13.

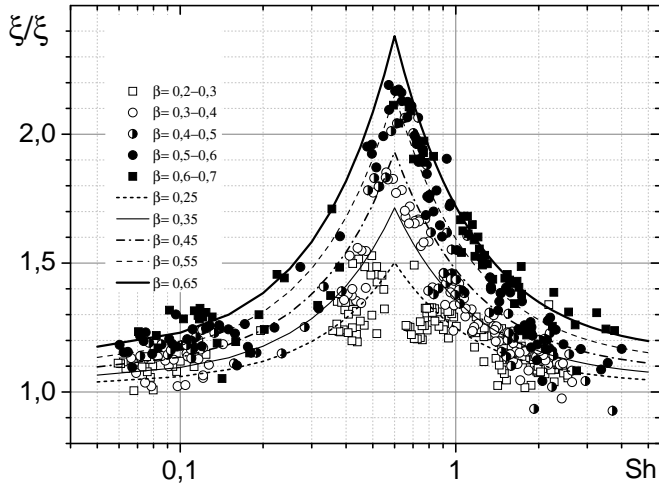
t/D = 1 2,3

14.

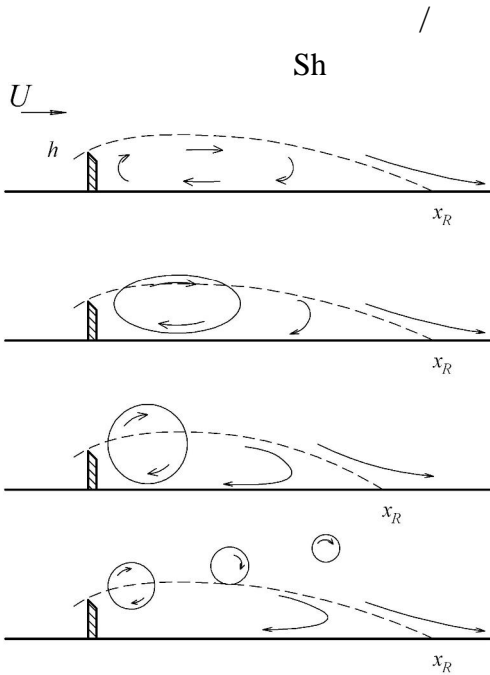
Sh = 0,6

7 %

$$\xi/\xi = 1 + 0,31 \text{Sh}^{1,75} + 1,9 \text{Sh}^{-1,5} |\ln(\text{Sh}/0,6)| \quad (9)$$



14 -



15 -

- 1 -
- 2 -
- 3 -
- 4 -

/ (14)

- 1
- 2
- 3
- 4

Sh = 0,6.

14. / , « » , .

15 ()

0,31^{1,75} , (Sh)

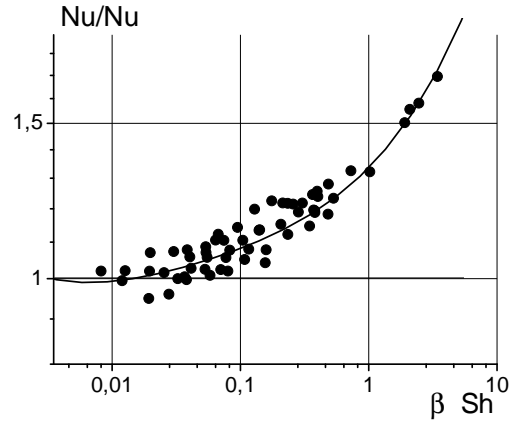
Sh /

15 (

2012. 3. 442-449).

Sh = 0,6

16

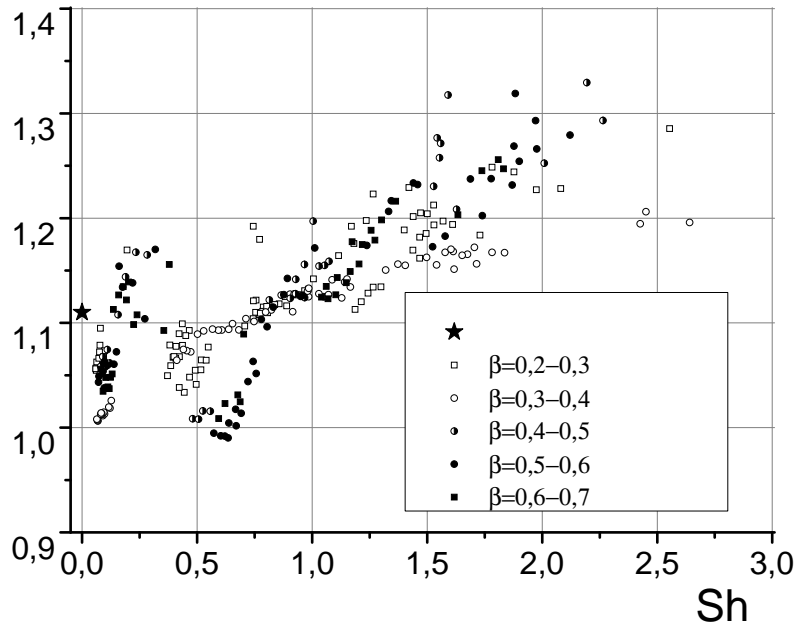


16 -

$$= \frac{Nu}{Nu} \left(\frac{Sh}{Sh} \right)^{1/3}$$

Sh

17.



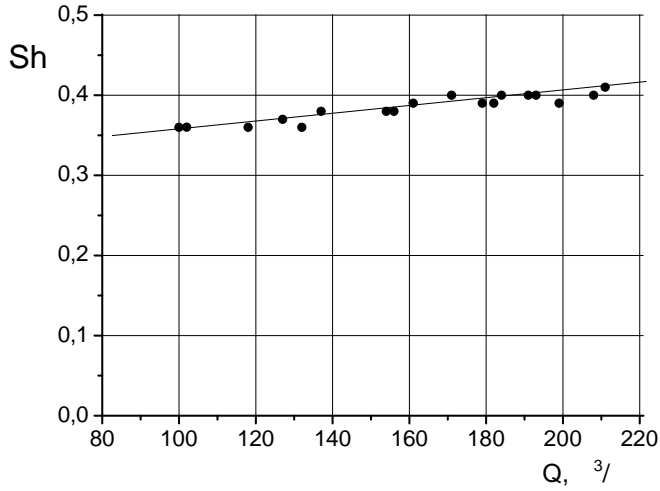
17 -

Sh

Sh = 0,6

= 1,11 (17, ★).

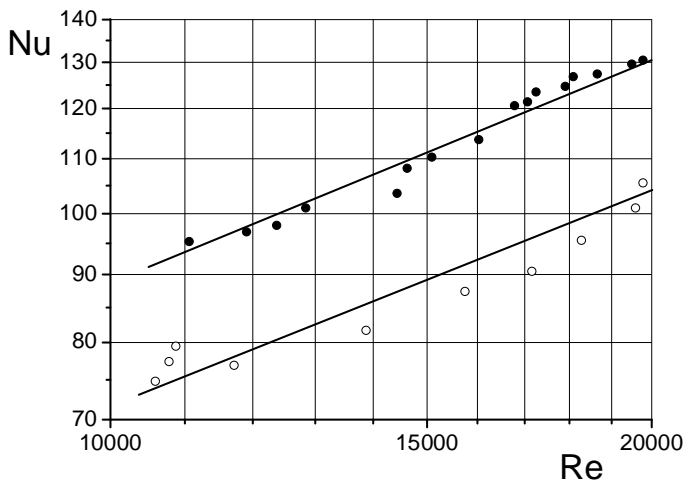
Sh > 1



18 -
) Sh

(Q

= 0,173 - 0,235.



19 -

(Sh \cong 0,4)

Q (18).

Sh > 1.

19.

20...25 %.

1.

2.

$$Re = 11000 - 41000,$$

$$= 0,2 - 0,7,$$

$$Sh = 0,01 - 4,$$

-

-

7%

$$/ = 1 + 0,31^{1,75} + 1,9^{-1,5|\ln(Sh/0,6)|};$$

$$Sh = 0,6$$

-

3.

4.

20...25 %

1.

2.

3.

XVIII

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- 4. «», 23-27 2011 ., -
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- 27 5. 2012 .: 4 .- : - , 2012. - .2 - .194-195.
 VIII - / . . . // VII -
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- 6. 2012 . - : - - , 2012. -
 .172.
- XIX - / . . . , . . . // -
- 7. «» . 20-24 2013 ., - , .
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- 8. «XXI 2013 . - : - (. . . . - ,
 2013. - .II. - .266-267.
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- 9. «» , 10-12 2014 . - : , 2014. - .102-106.
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- 10. . 27-31 2014 ., . - .: .
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- 2014 ., . - .: , 2014. - .3. - .67-68.
 11. / . . . , . . . //
- 12. . 27-31 2014 ., . - .: , 2014. -
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- XXXI - / . . . , . . . //
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60×84 1/16. . . . 0,93 120. 37. .

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