Critical flow at pressurized and freesurface conduits
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by Jerzy Mroz (Author)
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The author proposes a redefinition of critical flow conditions that become universal for pressurised flows, free-surface flow conditions in any shape of channel cross-sectional areas. In fact, the Darcy-Weisbach formula gives the head loss over the length in either a circular pipe or open channel in the same way. The crucial obstacle in the use of the Moody diagram is that one needs to know a priori the relative roughness of the channel, so in fact the information on surface structural property should be known in advance. In practical applications this is not possible. The author proposes how to tackle this problem effectively and seriously with diagrams presented in the book. The book is factual, hard-hitting and definitely provides new, never-before-published material.

Product details

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Product Description
Review
The following does not constitute a typical editorial review as my opinion might be burdened with subjective observation of the development of the monograph. Namely, this book has been regularly updated and reviewed in consultancy with me. The following and drawbacks of this report. I am not going, however to analyze line by line the correctness of the text as this work has apparently been done by Prof. Strupczewski. This work devoted to classical problems of hydraulic research and as such in its conceptual part mostly refers to rather old literature. But examples and discussions are drawn from relatively new publications. The study in fact constitutes a reanalysis of the so-called Moody diagram which forms one of the most widely used methods for evaluating the friction factor. That classical Moody diagram shows the friction factor plotted versus the Reynolds number with a series of parametric curves related to the relative roughness. These curves were generated from experimental data. The crucial obstacle in use of the Moody diagram is that one needs to know a priori the relative roughness of the channel so in fact the information on surface textural property should be known in advance. In practical applications we are not often in such convenient situation. Author proposes how to tackle this problem effectively and seriously. In his considerations Author also proposes a redifinition of critical flow conditions which in his study become universal for the

pressurized flows and free-surface flows of any shape channels croos - section areas. In fact, if we look at e.g. Darcy-Weisbach formula which gives the head loss over a length in either a circular pipe or open channel in the same way, such universality of critical flow conditions seems not to be wrong (although classical literature reveals rather different tradition in this respect). As we know the Moody diagram is a convenient and sufficiently accurate means of determining the value of the friction factor when solving problems by manual calculations. Similarly the diagram proposed by Author is useful for rather manual calculations so it is a good tool to carve out the intuition or as the first assessment but obviously together with the development of numerical tools other methods have become available for the users. This should be stressed in the text! This short monograph is well equipped in the analyses of various cases with data taken from rich literature. In principle the results of computations agree astonishingly well with the described examples and at the same time Author's methods turn out to be much simpler than the ones used in other publications. The book under consideration - in contrast to what has been said in Preface - is not relevant for graduate students. The presented material requires some experience and critical overlook of the problems related to the description of roughness in open and pressurized channels. Although the book refers to rather classical problems it is not easy for the reader. The style of the text is rather rough and shows a bit a lack of practice in writing the scientific texts. Nevertheless I consider this short monograph worth publishing (after some editorial polishing). Its strength is that it pertains to the principles of hydraulic research. It is rather unique nowadays that people treat with such care the basics of the scientific field and I find it as an advantage that numerical methods are not used in the text. This helps building intuition and understanding of principles. The book is factual, hard-hitting and definitely provides new, never before published material. Therefore I recommend it for publishing. --Pawel Rowinski, Prof. dr hab. / Institute of Geophisics Polish Academy of Sciences v-ce President

No publications on the link of critical flow with pressurized flow are known till now. It is common practice that the Bakhmeteff open channel critical flow condition derivation concept given with the assumption of the specific energy head H, has been accepted by the hydraulic community for nearly one hundred years. Bakhmeteff critical flow condition concept h = v2 / g and the Froude number Fr = v / g h, obtained with, taken for the sake of simplicity, rectangular flow cross-section with the assumption b » h, for roughly satisfie open channel flow, are not adopted if the flow cross-section is compound, and have no physical meaning if flow is pressurized. Kay Melvin (cited in Ref. 35) states that: 'the physical significance of specific energy beyond its simple definition is not so obvious and many engineers struggle with it'. The author's critical flow condition derivation concept is presented with the flux kinetic energy head HFL. The difference between specific energy and flux kinetic energy is clearly shown by Kunda P.K. and Cohen I.M. (Ref. 42). Kundu and Cohen stated that flux energy head HFL represents the flux per area perpendicular to the propagation direction, and H represents specific energy head per unit horizontal area. In contrast to Bakhmeteff, the author's concept of expressing the critical flow condition is presented with flux kinetic energy head HFL by considering pressurized flow, flowing through the horizontal circular cross-section non-parallel-sided duct. In order to deal completely with this kind of another critical flow problem presentation, it is necessary to device that the flow is presented by the flux kinetic energy head HFL with the assumption of flow cross-section constant specific energy head H, referred to the duct axis as datum and constant dischargeQ. One dimensional steady flow, Euler equation Eq. (1.1) and continuity equation Eq. (1.2) examination yield critical flow condition formula as Rh=v2 / 2g and modified Froude number as FrM = v / 2g Rh. 'A flow is said to be critical if the hydraulic radius equals exactly the velocity head'. The presented work brings a new look on a number of problems existing in hydraulics. Critical flow condition formula and modified Froude number are applicable to the both free-surface and pressurized flows. The Darcy-Wesibach formula is given as the function of the modified Froude number. The concise set formulas such as: modified Froude number, Darcy-Weisbach and Colebrook-White allow to construct a universal resistance diagram, f(FrM , Sf), used for steady flow in practical channels and pressurized conduits applicable both for plastic pipes and boulder strewn canyons, Newtonian and non-Newtonian flows. Diagrams Fig. 2.1; Fig. 2.2; Fig. 2.3. were not available to the Task Force Committee on Hydromechanics of the Hydraulic Division (Ref. 53). The relationship between the modified Froude number Eq. (1.19.1) and weir structure overlow discharge given as hydraulic radius-discharge [Rh - Q], equation Eq. (8.2) has the same structure for various throats and geometries. Fig. 8.4 to Fig. 8.13. Vedernikov stable flow criterion given with the modified Froude number enables to exclude shape factor from Vedernikov formula (Eq. 7.1). The stability flow criterion, Rh = v2 / 8g Eq. (7.5) is given for the modified Froude number FrMs = 2.0. Difficulties associated with several methods for compound channel critical depth computations are simply solved by application of the modified Froude number, Fig. 11.8.2, Fig. 11.8.3a and Fig. 11.8.3b. The reasons for the possibility of their appearance are presented too, Fig. 11.8.4 and Fig. 11.8.5. Pressurized pipe outlet power versus the modified Froude number shows that the flow conditions under which pipelines transmit the maximum power for a given size are critical flow conditions, Fig. 5.1. --Witold G. Strupczewski, Prof. dr hab. / Institute of Geophysics, Polish Academy of Sciences (PAN)

The author 'links the coefficient of head-loss (Darcy-Weisbach coefficient) with the Froude number. This is a novel approach since the traditional way to define head losses is to link them to the Reynolds number, so much so that the very definition 'Froude number' for pressurized flow is not well acknowledged by engineers. The author's definition of the Froude number for such conditions is derived from the definition of critical pressurized flow. An advantage of the author's approach becomes clear with the formula he derives for critical flow (Fr = 1.0) namely that loss coefficient in the Darcy-Weisbach formula is equal to the four times energy gradient f = 4 h / L. This allows for easy measurements of real head losses in existing networks as functions of discharge. Then a number of interesting relationships between discharges Q, pipe diameters D, head loss h, and head loss coefficient f can be derived. This paper is of interest to design engineers because of the relationships mentioned above. It is possible that the expression of head loss coefficient in terms of the Froude number will lead to simple design approach'. This opinion was prepared when the author was studying pressurized critical flow conditions only – Jean Cunge, Phd

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