Pipe Sizing

for

Building Services

Paul Funnell

In the interests of the Construction Industry
for
the Advancement of Knowledge

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For Paul Funnell

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THE AUTHOR

Paul Funnell was born and raised in Camden, a small country town southwest of Sydney, Australia. He graduated from Liverpool Technical and Further Education College in 1969 as a plumber, drainer and gas fitter. After relocating to Queensland in 1971 he advanced his knowledge through post-graduate Plumbing and Business Management courses.

In 1980 he commenced his own practice as a plumbing design engineer and retired after twenty years to concentrate on the design and development of computer software, specialising in applications for the building and construction industry. To date the portfolio of software includes estimating, costing and pipe sizing programs, two of which have won the Asia Pacific Information Technology Awards for Excellence: the ***'Contractor's Pack'*** in 2000 and ***'WaterFlow pipe sizing'*** in 2001.

In 1981 Paul was appointed as a part-time lecturer in Engineering Services at the Queensland University of Technology, a position he enjoyed for 14 years. Over the years Paul has been responsible for the successful plumbing design for major tourist resorts, high-rise and public buildings. The knowledge and skills he has attained over many years as a plumbing design engineer have provided a wealth of experience, which he is keen to share with others in the industry.

Paul is active in the building and construction industries, with a special interest in education. He has served on numerous education committees and was chairman of the Course Advisory Committee for the Diploma of Engineering, Plumbing Design.

Paul is a life member of the Association of Hydraulic Services Consultants Australia Inc.

This book is dedicated to all young design engineers, with the expectation they will be able to achieve and maintain a higher degree of accuracy in pipe sizing through the knowledge gained from this textbook.

ACKNOWLEDGMENTS

I extend my appreciation to all those who have given their time, effort and experience in assisting me to achieve the desired result in producing this textbook.

A special thanks to Allan Archie for his contribution to Chapter 8 Water Hammer, a topic on which he is recognised as an authority. Allan is an experienced educator in the plumbing industry, with over 35 years' experience.

I also extend my appreciation to Allan Archie and Ken Crase as my technical advisors. Ken is a professional plumbing design consultant, specialising in water flows and pipe sizing within building structures.

I thank Neil McPherson for his contribution. Neil's many years as a trade teacher and his expertise regarding copper tube, was very helpful.

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AUTHOR'S NOTE

The aim of ***Pipe Sizing for Building Services*** is to provide the knowledge for 'best practice pipe sizing design'; its scope is greater than to simply cover minimum requirements as set down in standards. The author does not intend to include rules and regulations, which are more than adequately explained in standards provided by government legislation. This text should be read in conjunction with such standards.

Design engineers are expected to comply with rules and regulations that fall short of providing good pipe sizing information. Standards do not attempt to cover methods, procedures or calculations for arriving at the correct pipe size for any given project. ***Pipe Sizing for Building Services*** addresses this situation by providing the necessary knowledge and skills for best practice in the design of pipe systems.

Standards are intended to provide guidelines for minimum flow rates and pressures as well as Possible and Probable Flow tables. However, as the tables provided in the standards are based on minimum requirements, the designer should satisfy him or herself of their sufficiency for optimum design practices.

There are a number of instances in this text where tables and charts differ marginally from published standards which have been used over the years. All data in this text has been computer generated using the correct formulas, flows and factors as detailed in Chapter 1, which are required to achieve a greater degree of accuracy than has ever been possible. Furthermore, on-site data has been collected to confirm the accuracy of the information.

To cater for different methods of measurement, water pressure has been expressed in 'metres head' (m/h), kilopascals (kPa) and bar.

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OVERVIEW

Since water first flowed through pipes, there has been a belief that accurate pipe sizing was a virtual impossibility, or simply too difficult to achieve. When considering the charts and tables available, there is some truth to this; it is not possible to take into account all the variables that need to be considered when using these tables.

In the age of advanced technology, this situation has changed and those who don't move with the times will be left behind. Software programs are available which produce the calculations, friction losses and provide the optimum pipe sizing with a higher degree of accuracy than can ever be achieved using charts and tables.

With the introduction of electronic methods of calculating pipe sizes, a design engineer could easily lose the professional skills required to guarantee a good design; or even worse, young engineers may never have the opportunity to gain the knowledge they need. The ability to assess local conditions and apply experience and professional skills is vital in attaining best engineering practice in the design of pipe systems.

It is paramount that design engineers understand the principles of water flow through pipes for sizing purposes. Such knowledge and skills will provide the opportunity to adjust and improve the pipe sizing design for any given situation. A designer must know how and when to apply correct calculations involving flows and velocities, to achieve the optimum result.

The need for this book, ***Pipe Sizing for Building Services*** was evident from the author's observations regarding large variations in pipe sizing designs presented by different design engineers.

The practice of over-sizing pipes is unacceptable and this text will help the designer 'get it right the first time'. Variations in pipe sizes can also be found between designers within the same company on similar projects. There is a perception that two projects of similar construction will require exactly the same pipe sizes when constructed a short distance apart. This may in fact be the case; however, every project should be treated individually due to the possible variations that can be experienced.

This reference/textbook presents and emphasises the following important principles that should be at the forefront of every design engineer's mind:

Flexibility

It is true no two projects are exactly the same. In any design, particularly when using a software program, the engineer must be able to apply his or her own local knowledge, skills and experience.

Accuracy

In the past it has been difficult to take into account all the necessary variables when using tables, charts and graphs provided for the various pipe materials in the market place. This text details the information required to achieve the desired accuracy for best practice pipe sizing.

Consistency

Consistency is an extremely important component of any design. It has been stated that no two projects will be exactly the same. It is equally true that particular projects may not be as different as first thought. Therefore, in order for clients to have confidence in the designer's ability, there must be consistency. Guessing pipe sizes will lead to inconsistency and problems for the end user. There will be many opportunities in this text for the design engineer to use his or her own guidelines that apply to their local area, which incorporate a particular style for a particular project. Consistency must prevail in all cases as it provides a foundation on which minor adjustments can be applied if and when required.

Time Savings

Through gaining the knowledge presented in this text, the design engineer will always be in a position to employ the most accurate method of calculating the correct pipe sizing for any particular project. This will provide valuable time savings for the design engineer and will maximise the efficiency of the company.

Benefits

There are many benefits in designing the potable water system efficiently and sizing pipes accurately. At the time of publication fresh water was considered a valuable commodity in short supply and it was evident water would become even more scarce in future years. There is a renewed emphasis on the importance of conserving water and new devices are being introduced to help achieve a reduction in the massive waste that is occurring.

Accurately sizing pipes will provide the end user with sufficient hot and cold water to meet their requirements and contribute toward large cost savings in avoiding excess water consumption, as well as reduced capital costs for building construction.

The environment benefits from any reduction of water consumption, through better management and less waste. The environment also benefits where industry is able to reduce the diameter of the pipes being used.

The end user benefits by receiving a balanced system. Having a shower that does not go cold when the kitchen tap or washing machine is turned on, is most important.

Note: Owing to the large variety in internal diameters of various pipes available in the market place, nominal diameters are used throughout this text. It is industry practice to state nominal diameters as DN ‘Diameter Nominal’. The following table provides the ‘Equivalent Sizes’ for each DN and imperial conversion, used in this text.

Diameter Nominal DN - mm	Internal Diameter ID - mm	Imperial Inches
15	10.88	½"
20	17.01	¾"
25	22.96	1"
32	29.31	1¼"
40	35.66	1½"
50	48.44	2"
65	61.06	2½"
80	72.94	3"
100	98.34	4"
125	123.74	5"
150	148.34	6"
200	199.14	8"

DN Copper Pipe Sizes with Actual Internal Diameters and Imperial Equivalents

Distribution of Water

To minimise the risk of Legionella, the ‘Thermostatic Mixing Valve Manufacturers Association’ (Great Britian) in their ‘Recommended Code of Practice for Safe Working Temperatures’ state that water should be distributed to the point of mixing at a temperature of less than 20˚C for cold water, or above 55˚C for hot water. The code also recommends hot water be stored at or above 60˚C. Refer to Chapter 7 for recommended safe hot water temperatures.

Abbreviations & Definitions

Abbreviations

B	basin
Bth	bath
BV	balancing valve
CWR	cold water riser
dia.	diameter of pipe
DN	Diameter Nominal
EPL	equivalent pipe length
HWU	hot water unit
ID	inside diameter of pipe
kl	kilolitres
kPa	kilopascals
LT	laundry tubs
L/s	litres per second
L/m	litres per minute
L/h	litres per hour
m/h	metres head
mm	millimetres
OD	outside diameter of pipe
RL	reduced level
Sk.	sink
Shr	shower
SS	source of supply
WM	washing machine

Definitions

Ambient temperature: The average temperature of the atmosphere at a given location. This text refers to the ambient temperature of water to mean the most likely temperature of water in the water mains.

Flow pressure: The pressure recorded while there is a flow from the outlet/fixture.

Hardness of water: Natural water contains impurities in various proportions; the main offenders are the soluble salts of magnesium and calcium. The more minerals in the water, the 'harder' it will be.

Head loss: The difference in pressure of a fluid between two points (one high the other low), expressed in metres head (m/h) kilopascals (kPa) or bar.

Head pressure: The pressure reading taken at a given point in the pipe system. It can be expressed in metres head (m/h) kilopascals (kPa) or bar.

Header tank: A water storage tank located at the top of a building.

Litre: A metric unit of capacity equivalent to 1000 millilitres.

Local authority: A government department or statutory body which has jurisdiction over the water distribution system.

Most disadvantaged outlet: The fixture or outlet with the highest head loss, caused by a combination of friction in the pipe and fittings and the loss due to static head. It is not necessarily the furthest fixture or outlet from the water supply.

pH: A measure of the acidity or alkalinity of water. On a scale of 1 to 14 a score below 7 represents acidic water and a score above 7 represents alkaline water.

Potable water: Water that is of a quality and standard suitable for drinking.

Pressure-limiting valve: A valve used to limit water pressure with minimum loss of flow.

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Reduced Level: A surveying term referring to levels that are coordinated and relate to each other.

Residual pressure: The excess pressure beyond that required to service the outlet after all head losses and static pressure have been taken into account.

Static head: That part of the total head/pressure, which is equal to the static height difference between the inlet and outlet of a pipe system.

Static pressure: The pressure recorded when there is no flow or movement in the reticulating pipe system.

Velocity: The speed at which water passes through the pipes.

Viscosity: The property of a fluid (in this case water) in resisting change in the shape or arrangement of its elements during flow. The lower the viscosity, the ‘thinner’ the water and the more easily it flows.