
Contents

Preface	ix
Chapter 1. Mechanics and Fluid	1
1.1. Introduction	1
1.1.1. Mechanics: what to remember	1
1.1.2. Momentum theorem	4
1.1.3. Kinetic energy theorem	5
1.1.4. Forces deriving from a potential	6
1.1.5. Conserving the energy of a material point	8
1.2. The “fluid state”	9
1.2.1. Fluid properties	9
1.2.2. Forces applied to a fluid	12
1.3. How to broach a question in fluid mechanics	22
1.3.1. The different approaches of fluid mechanics	22
1.3.2. Strategies for arriving at a reasoned solution	23
1.4. Conclusion	25
Chapter 2. Immobile Fluid	27
2.1. Introduction	27
2.1.1. The fundamental theorem of fluid statics	27
2.2. Determining the interface position and related questions	30
2.2.1. Fluid statics. Incompressible fluids subject to gravity	30
2.2.2. Case of volume forces deriving from a potential	43
2.2.3. Case for compressible fluids	51

2.3. Calculating the thrusts	57
2.3.1. Methods	57
2.3.2. Thrusts on bodies that are totally immersed in incompressible fluids	58
2.3.3. Calculating the thrust on a wall	79
Chapter 3. A Description of Flows	87
3.1. Introduction	87
3.2. The description of a fluid flow	88
3.2.1. The Eulerian and Lagrangian description	88
3.2.2. Kinematic elements	91
3.2. A first principle of physics: the principle of continuity	96
3.2.1. The principle of continuity	96
3.3. Notions and recalls on potential flows	102
3.3.1. Definition	102
3.3.2. Determination	102
3.3.3. Determining streamlines	104
3.3.4. Curl of the velocity	104
3.4. Example of kinematic calculations	105
Chapter 4. Dynamics of Inviscid Fluids	127
4.1. Introduction	127
4.2. The Bernoulli theorem: proof	127
4.2.1. What to retain	133
4.2.2. Energetic interpretation of the Bernoulli theorem	134
4.2.3. Physical interpretation of the Bernoulli theorem	135
4.2.4. “Constant energy” flows	135
4.3. Applications of the Bernoulli theorem	136
4.3.1. Methodology for the resolution of a problem using the Bernoulli theorem	136
4.3.2. Determining an applicate	145
4.3.3. Draining and filling	150
4.3.4. Mobile reference frame	157
4.3.5. Time-dependent filling	168
4.4. Draining of the ballasts	177
4.5. Synthetic problems	179
Chapter 5. Viscous Fluid Flows: Calculating Head Losses	197
5.1. Introduction	197
5.2. The notion of head: generalized heads	198

5.3. Practical calculation of a head loss	200
5.3.1. Introduction	200
5.3.2. Linear head losses.	201
5.3.3. Singular loss of head	203
5.4. Circuit calculations	205
Chapter 6. Calculation of Thrust and Propulsion	235
6.1. Introduction	235
6.2. Euler's theorem and proof	235
6.2.1. Euler's first theorem and proof	236
6.3. Thrust of a jet propulsion system, and propulsive efficiency	240
6.3.1. Calculation of the thrust of an "airplane engine".	240
6.3.2. Calculation of the propulsive efficiency	244
6.3.3. Calculation of the thrust of a rocket engine.	246
6.3.4. Some applications of Euler's theorem to jet propulsion	247
6.4. Thrust exerted by a jet on a fixed wall	263
6.4.1. Calculation of the thrust applied to a wall by a jet	263
6.4.2. Jet impacting on a wall	266
6.5. Other applications for Euler's theorems	272
6.5.1. Application of Euler's theorem to a head loss calculation	272
6.5.2. A case for the application of Euler's second theorem	277
Bibliography	283
Index	285