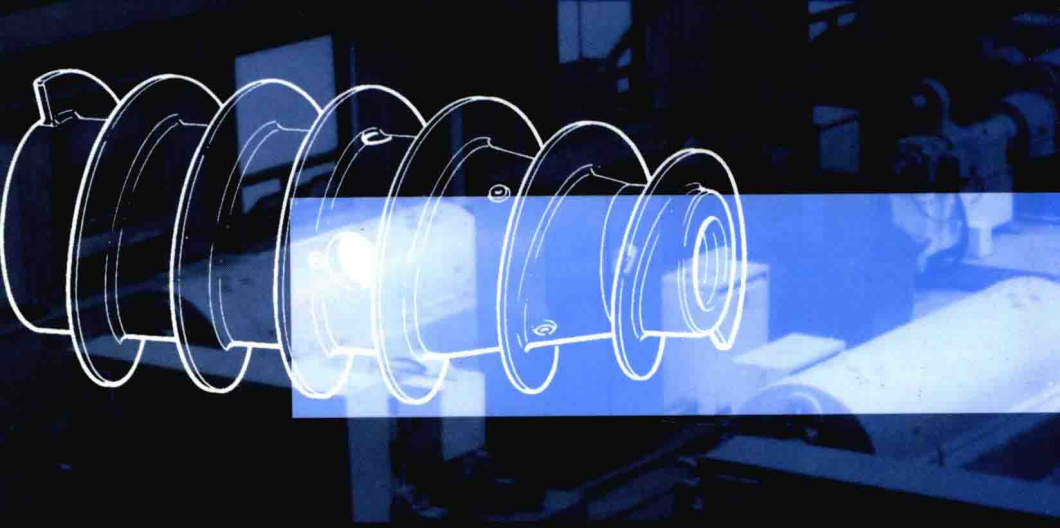

Decanter Centrifuge Handbook

Alan Records and
Ken Sutherland

First Edition

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1st Edition

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Preface and Acknowledgements

By virtue of its title, which involves the word "handbook", this book is intended, above all else, to be useful. Its aims include the explanation of the nature and methods of operation of the decanter centrifuge, and a description of the kind of performance that might be expected from a decanter.

The decanter centrifuge is a device for continuously separating particulate solids from a suspending liquid or liquids by sedimentation and decanting. As such, it is part of the general range of sedimenting, filtering and other mechanical equipment used for separation processes. A distinguished range of books exists that describes this complete spectrum of equipment, and the processes by which they operate. A previous book covers the whole range of centrifuges, both sedimenting (like the decanter) and filtering, but this is the first book to deal solely with the solid-bowl, scroll-discharge centrifuge, which is the decanter.

The book is aimed at all those for whom the decanter may be part of their studies, of their research, or of their working life. It is intended to be of value in undergraduate courses on filtration and separation, but it will also offer the practising engineer in end-user companies much that is of direct value to the daily job of designing, specifying or operating this sophisticatedly engineered, but very useful, piece of processing equipment. This handbook will find use in research establishments and equipment manufacturers' engineering departments, as it gives guidance on basic design and operating features, some in regular use and some only recently introduced to the market.

This essentially practical text nevertheless covers the underlying theory of centrifugal sedimentation separations in some detail, which further extends its usefulness to the research or design engineer looking for new ideas.

The arrangement of the handbook follows a logical pattern: a general introduction, followed by technical descriptions of equipment features and the industrial uses of the decanter. Then comes the theory of the decanter's design, and detailed descriptions of operational and test procedures. The book finishes with some marketing data, and descriptions of the equipment ranges of the main manufacturers.

The authors (both Chartered Chemical Engineers) have a wealth of experience in the decanter business:

- Alan Records retired from a senior equipment application and development role with Alfa Laval, after almost a full lifetime's job involved with decanters, covering research, design, commissioning, operation and service, in a wide range of industrial applications; and
- Ken Sutherland, for a time Technical Manager for Sharples, has later been heavily involved with the marketing aspects of separation equipment, including centrifuges.

The putting together of a book of this nature requires the help and co-operation of many individuals and organisations. The contributions, help, advice, work and kind permissions of those mentioned below are most gratefully acknowledged.

Lenny Shapiro and Jan Cederqvist contributed to the mechanical information, while Bert Guille assisted with the electrical content. The process data were obtained as a result of painstaking work in the field, often in far less than a salubrious environment, by numerous field engineers, our former colleagues, and in particular John Joyce, Betina Pedersen, and Keith Smith. Apologies are extended to all those not mentioned.

Denis Locke contributed to the work on many of the illustrations, professionally executed by Mike Nicklinson.

Graham Dawson, with the help of some of his former colleagues, advised on the section on flocculant technology. Keith Kernahan advised on the details of the Viscotherm equipment.

The Triton Electronic Company co-operated in providing photographs and details of their CST equipment.

The decanter centrifuge market is a highly competitive one, and thus manufacturers are, understandably, reticent in providing specific data and information on their products. Without such data and information, however, this book would be reduced in value. The authors are therefore especially grateful for the data supplied by the companies Alfa Laval, Baker Process (Bird Machine and Bird Humboldt), Broadbent, Centriquip, Centrisys, Flottweg, Gennaretti, Guinard, Hiller, Hutchison-Hayes, Noxon, Pennwalt India, Pieralisi, Siebtechnik, and Westfalia/Niro. Permission to reproduce sketches and drawings has been obtained from Alfa Laval, Bird Machine, Bird Humboldt, Broadbent, Centriquip, Centrisys, Cyclo, Flottweg, Noxon, Siebtechnik, Tomal, Viscotherm and Westfalia Separator.

Finally, gratitude is expressed to Bent Madsen and his colleagues for checking the early manuscripts. The book owes its origin to Nick Corner-Walker, then Director of Engineering with Alfa Laval, to whom the authors are indebted for the inspiration, for his personal support, and for putting the resources of a major manufacturer of decanters behind the venture. The

authors are very happy to acknowledge that debt here, but also to acknowledge the input from the other companies whose ideas and illustrations have been used at the appropriate parts of the text.

To these, and all of the other workers involved with the decanter for the 60 years of its effective operating history, the authors express their thanks.

Alan Records
Ken Sutherland

CONTENTS

CHAPTER 1

Introduction

The decanter centrifuge has become a major processing tool in a wide range of liquid/solid separation applications. This handbook aims to be a thorough introduction to the design, performance and application of the decanter. It aims also to be a useful guide for the centrifuge engineer, both in equipment manufacturing companies and in the end-user companies, and their associated contractors and consultancies.

The handbook's first chapter introduces the reader to the decanter, to its history and to the manufacturing sector within which it is made. The contents of this chapter are intentionally brief, with major expansion of the topics covered in later chapters of the book.

1.1 The Decanter Centrifuge

The solid-bowl scroll-discharge centrifuge — now almost universally known as the decanter centrifuge — has, indeed, become the workhorse of a wide range of liquid/solid separation activities. Its application to the dewatering of waste sludges has made it a most valuable tool in combating environmental pollution. This has made the decanter a well-known and widely appreciated piece of equipment.

1.1.1 The basic decanter

Although a complicated piece of machinery, the decanter centrifuge embodies a simple principle, that of the screw conveyor. In basic terms, the decanter comprises a solid cylindrical bowl, rotating at high speed. Inside the bowl is a scroll (screw conveyor) rotating at a slightly different speed. The differential speed between bowl and scroll provides the conveying motion to collect and remove the solids, which accumulate at the bowl wall.

A slurry of liquid and suspended solids is fed along the centre line, to some fixed position within the bowl, and is accelerated outwards to join the pond of liquid held on the bowl wall by the centrifugal force. This same force then causes the suspended solids to settle, and accumulate at the bowl wall. The clarified liquid then flows along the bowl, to leave at one end of it, over some kind of weir design, which sets the level of the liquid surface in the bowl.

The other end of the bowl is sloped inwards, towards the centre, thus providing a beach, up which the solids are conveyed, to be discharged from the bowl, at the top of the beach. Whilst the solids are conveyed up the beach, some, hopefully most, of the entrained liquid drains back into the pond, to join the liquid flow towards the far end.

The scroll usually is carried on a hollow axial hub, through which the slurry feed tube passes to the feed zone. The diameter, the number, and the pitch of the conveyor flights are chosen to match the needs of the slurry being treated — as are the depth of the pond, the length of the bowl, the conveyor differential speed, and the angle of slope of the beach.

Most decanters operate with their axis horizontal, in which case they usually are mounted in substantial bearings at each end of the bowl. Vertical

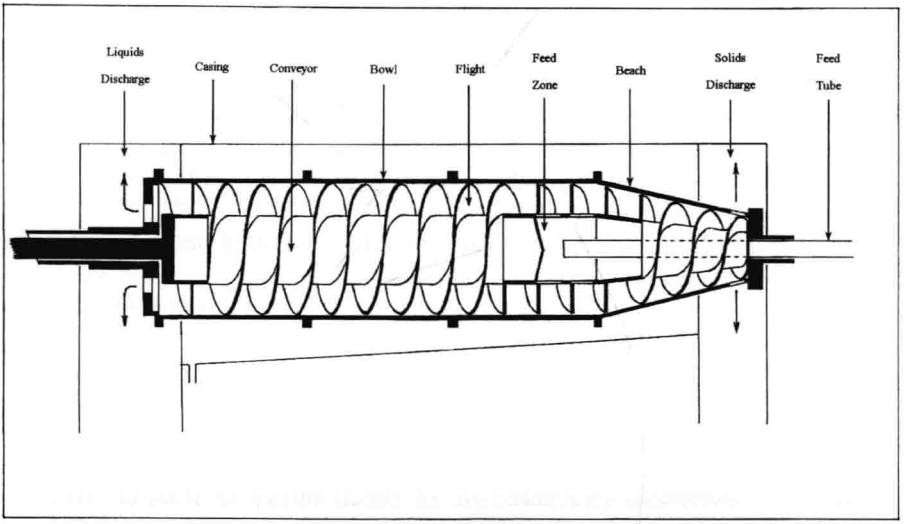

Figure 1.1. The main operating parts of a decanter centrifuge.

operation is possible, in which case the bowl is carried only on one set of bearings, at the top. If the decanter is short, then cantilevered horizontal operation is also possible, with bearings at one end only.

The rotating bowl is enclosed in a casing, which is divided to ensure that the discharged liquid (the "centrate") and solids cannot remix after separation.

The basic decanter is completed with a drive motor, usually electrical, and a gearbox, which controls the differential speed of the conveyor.

Aspects of the physical forms of the decanter in its different versions are described in Chapter 2.

1.1.2 Separation principle

The decanter operates mainly by sedimentation, a process causing the separation of suspended solids by virtue of their higher density than the liquid in which they are suspended. If the density difference is high, then gravity may provide sufficient driving force for the separation to occur in a reasonable time — as is the case with large-tank clarifiers and clariflocculators, or with lamella and inclined-plate separators. If the difference in density is small, or the particle size is very small, then gravity separation would take too long, and the separation force must be augmented by the imposition of centrifugal forces many times that of gravity alone.

The centrifugal force may be imposed by virtue of the flow of the slurry, as in a hydrocyclone, or by means of mechanically driven rotation, as in the sedimenting centrifuge.