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Emissions from Two-Stroke Engines

Marco Nuti
This book is dedicated to my two sons,
with the hope of a more friendly environment
in their futures.
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Foreword

It has been well over one hundred years since the conception by Sir Dugald Clerk of the two-stroke cycle engine, which generally has been favored for applications requiring high specific power and low specific weight. For comparison with four-stroke cycle engines, the following formula applies: $550 = 800$. (*Automotive Engineering*, August 1981, p. 92, Society of Automotive Engineers, Warrendale, PA 15096) That is, to obtain the same low- and mid-speed performance of a 550-cc two-stroke engine, the four-stroke engine must have a displacement of 800 cc.

The reason for the superior performance of the two-stroke engine is, of course, related to the fact that it has a power stroke every engine revolution. In a two-stroke engine, the intake and exhaust strokes of the four-stroke engine are replaced by a scavenging process. However, this scavenging process is the cause of the high hydrocarbon emissions from carbureted engines. At wide-open throttle, up to 30 to 40% of the air-fuel mixture is short-circuited directly to the exhaust system without participating in the in-cylinder combustion process.

These high hydrocarbon emissions, which once were tolerated, today are at odds with environmental regulations. How well and at what cost engineers reduce these emissions will determine how long the two-stroke engine survives in the twenty-first century.

Books on two-stroke engines are a precious few, and none have been devoted entirely to exhaust emissions. Therefore, this book is a welcome and important addition to the technical literature.
Dr. Marco Nuti, the author, is well qualified to discuss the subject of two-stroke exhaust emissions. Since 1969, he has been involved in the full range of engine research and development at Piaggio, including CAD, FEM/FEA, CFD, computer modeling, materials, components, and manufacturing technologies. In addition, Dr. Nuti has written more than 50 technical publications. Currently, he is in charge of Technical Innovation at Piaggio.

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January 10, 1998
First, I would like to thank Piaggio, where I have worked since 1969. Because of the company's commitment to serve and sometimes anticipate market needs by developing continuously improved products, I have been in a position to gain most of my knowledge about two-stroke engines.

Second, I would like to thank the Pisa Technical University, where I studied, and particularly the friends of the Mechanical Engineering Department, with whom beneficial cooperation has been possible.

Last, but not least, I would like to thank the young technical members of my staff and particularly Dr. David Caponi. Dr. Caponi inspired me to write this book with the goal of transferring to young engineers the knowledge that I acquired over many years.