



Methods for evaluating total of oil and grease on water

J T G S B Oliveira^{1*}, S. T. B. Oliveira-Filho² and R P B Costa-Félix³

¹ Fluid Measurement Sector – Directory of Legal Metrology - National Institute of Metrology, Quality and Technology, Av. Nossa Senhora das Graças, 50 – Xerém – Duque de Caxias – RJ – Brazil – 25250-020

² Beer Production Management - Directory of Operations – Coca-Cola Andina Brazil, Av Automóvel Clube, 4945 – Taquara – Duque de Caxias – RJ – Brazil – 22272-030.

³ Laboratory of Ultrasound - Directory of Scientific Metrology and Technology - National Institute of Metrology, Quality and Technology, Av. Nossa Senhora das Graças, 50 – Xerém – Duque de Caxias – RJ – Brazil - 25250-020

* jtoliveira@inmetro.gov.br

Abstract. This paper presents the results of a scoping review of different methodologies to determine the total amount of oil and grease in wastewater. This scoping review, but a part of doctorate research, and it intends to study the principal methodologies used today and analyse how their development occurred over time. For this reason, a search from the first paper found was performed and it was possible to notice the growth of research from the seventies until nowadays. Besides that, there is a logical correlation between world public policies and this growth. The first studies began with discussions about environment in the seventies and continued through the years. Every new world conference or public policy, new regulations were adopted, and new papers written. Since 1970's, 68,75% of research was written in the last decade, and almost 40% over the previous 2,5 years. It shows not only the relevance, but also how up-to-date this theme is.

1. Introduction

Concern for the environment as a policy proposal began in 1968 with the presentation of a report about programs needs to Human Environment and the first warning for environmental risks was in 1969 [1].

The first United Nations Conference on the Human Environment – UNEP - was created in 1972 in Stockholm. In the following year, the UNEP headquarters was inaugurated in Kenya and the first meeting of the Board of Directors occurred in Geneva, where Member States of the United Nations agreed to monitor, regulate, or prohibit the trade of endangered species.

Also in the 1970s, UNEP launched a program to manage the accelerated degradation of the world's oceans and coastal areas, adopted by sixteen Mediterranean countries [1].

The decade ended with the Bonn Convention, which supported cooperation in research and protection of 120 migratory species, and the Convention on Long-Range Transboundary Air Pollution, the world's first legally binding instrument that addressed regional air quality.



The 1980s began with UNEP's publication about World Conservation Strategy and definition of sustainable development concept. The world was convinced how necessary is to save and to conserve water, as an increasingly scarce resource and Montevideo Program was adopted and established priorities for global environmental legislation. All countries members of United Nations adopted Montreal Protocol on Substances that Deplete Ozone Layer [1].

Next UNEP, World Meteorological Organization, and Intergovernmental Panel on Climate Change adopted the concept of sustainable development in climate policies development. In addition, Basel Convention regulated the movement and disposal of hazardous waste.

In the 1990s, United Nations created the Global Environmental Facility (GEF), a United Nations Conference on Environment and Development took place in Rio de Janeiro and established Agenda 21, in addition to the signing of the multilateral treaties of the Framework Convention on United Nations on Climate Change and the Convention on Biological Diversity.

The United Nations Convention to Combat Desertification came into effect, Rotterdam Convention was launched to share responsibilities in relation to importation of pesticides and hazardous chemicals, and United Nations Global Compact aimed at encouraging companies to adopt sustainable, socially responsible and to report their implementation.

Cartagena Protocol on Biosafety was signed in 2000 with specific environmental targets. Then Stockholm Convention was adopted by 176 countries and Intergovernmental Panel on Climate Change was awarded the Nobel Peace Prize [1].

Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was launched at RIO+20 with reliable information on public policies. Then, at the 2014 Climate Summit, the healing of the ozone layer was evidenced due to the Montreal Protocol and in the following year, 195 countries adopted the first universal and legally binding global climate agreement.

The Climate Action Summit took place in 2019. The period between 2021 and 2030 was declared the decade to restore ecosystems to fight climate crisis and increase food security, water supply and biodiversity [1].

In this entire context, much was discussed. One of the most discussed issues was fossil fuels, their use, how to produce it with fewer injuries to environment, how to manage production, distribution, minimize or mitigate risks and how to substitute it.

Petroleum industry produces a high amount of water with oil during offshore extraction called produced water. The quality of this produced water is important mainly for environmental issues since it is discarded after passing through water treatment system. For that, this water must contain low concentration of oil and it is reinjected in this system until it reaches the value required by law [2].

In recent years much has been studied about discharge of produced water from oil and gas production. While Resolution Conama n° 393 of 2007 (Environment National Council) defines produced water as "*water normally produced together with oil*", OSPAR (Oslo-Paris Convention) is more precise and defines as "*water which is produced in oil and/or gas production operations and includes formation water, condensation water and re-produced injection water; it also includes water used for desalting oil*" [3][4].

From 2009 to 2019 around more than 300 million m³ of produced water were discharged in the Northeast Atlantic per year [4]. There are a few methods to determine total of oil and grease (TOG) in water, each one of them defines what oil in water is since the analysis is method-dependent [5].

To understand the evolution of this area research, a scoping review was realized. It is also important to know how interest in this subject has grown up since its first appearance.

Scoping reviews are a type of systematic identification of scientific literature that maps available evidence on a particular issue and allows to synthesize evidence. Besides that, it is also possible to clarify definitions and characterize concepts linked to methodological research.

Evidence synthesis is "*the review of what is known from existing research using systematic and explicit methods in order to clarify the evidence base*" to ensure the use of the best available evidence. For that it should follow a protocol with pre-specified objective, question(s), and inclusion/exclusion

criteria, comprehensive searching, protocol-driven screening, and selection of included sources, more than one author and use a methodological guidance and reporting standards for scoping reviews such as PRISMA (preferred reporting items for systematic reviews and meta-analysis) with extension for scoping reviews guidelines [6].

Prisma provides transparency to reviews of studies that present interventions on a specific issue. So, it is important to define databases where the search will be done, choose terms to use on searches, test the strategy and build flux as in figure 1.

2. Methodology

A Scoping review explores the main concepts about an issue and the methodology strategy of searching used in this review was Problem, Concepts and Context (PCC).

The problem studied is “total of oil and grease determination”; concept is “methodologies”; and context, “wastewater”. The research main question is “what are the possible methodologies to determinate oil and grease in wastewater?”

The search for scientific production was carried out in April 2023 in Scopus and Web of Science databases. These databases were chosen for the possibility of searching on web by using keywords and they are up to date. It was also possible to look for articles in different languages, without focusing on specific languages.

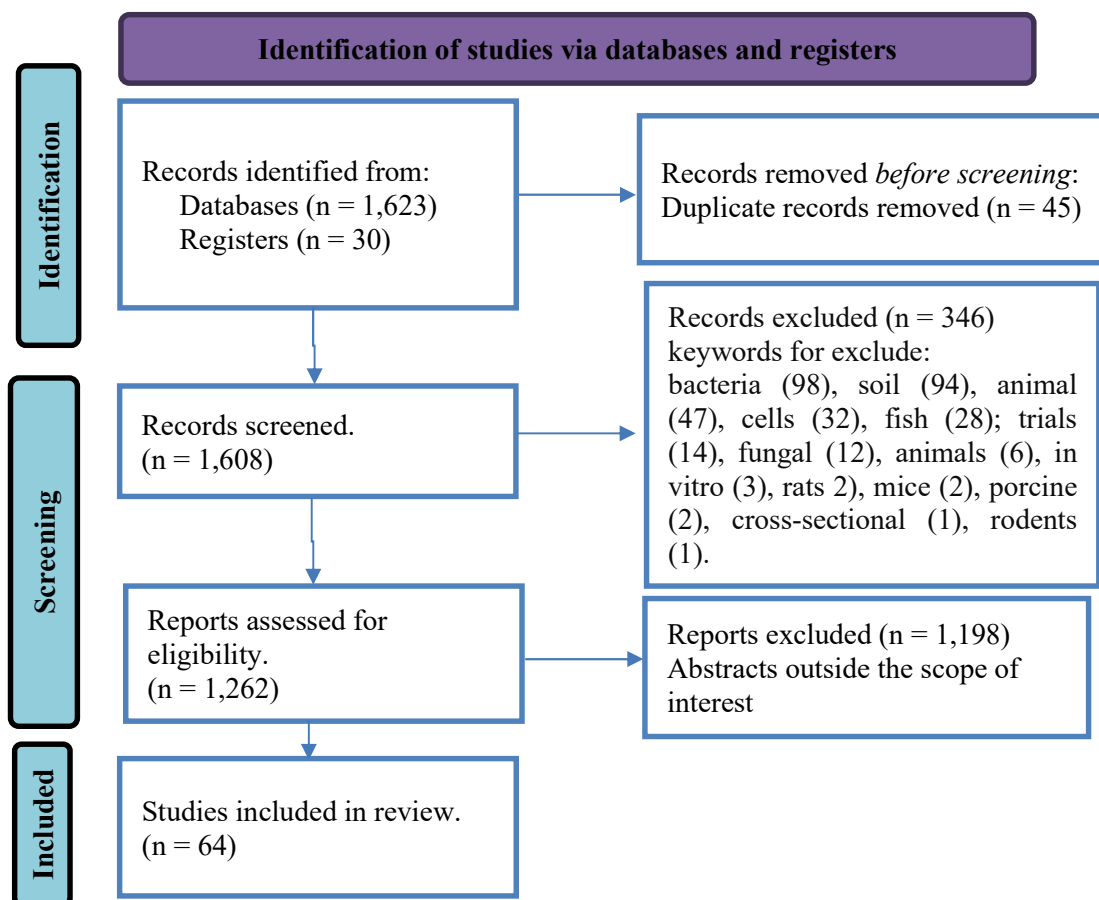


Figure 1: The figure shows the flowchart followed for this review (adapted from Page *et al.* (2020) and Sanches *et al.* (2018)) [7] [8].

2.1. Selection Procedures

Selection procedures were carried out in four steps. The first one was the descriptors choice submitted to databases. This scope review looked for the following keywords: oil AND grease AND determinat* AND wastewater.

In the second step, a web application was used to assist systematic reviews. Rayyan is an artificial intelligence tool that allows the collaboration of other researchers to analyze abstracts in an easier way. Then all the articles identified on the search were filtered on Rayyan.

The first filter was identifying duplicates in the research. Sometimes the same reference is found two or more times and they must be cleaned.

The third step was a blind papers mining performed with two collaborators to bring more confidence to mining. Then both researchers implemented filters separately. Some keywords not related to total of oil and grease determination were excluded as shown in figure 1.

Filters by year or language were not performed since the objective was also to know about how interested scientific community was on the subject over the years.

After that, the abstract of each paper was read by the two collaborators to identify the relevance of each one of them for this scoping review.

3. Results

The papers identified in databases (1,653) were sent to Rayyan and duplicates were recognized by AI and deleted (45). Based on some keywords identified, more 346 texts were removed from research, due to subjects related to fauna and flora preservation, not to metrological methods.

Then both collaborators read the abstracts and did their own selection. Some papers were included for reading; others excluded, since they were out of the scope of interest.

Collaborators presented divergence in opinions about the relevance of some papers to the scope in search and to solve it, it would be necessary bring another qualified opinion.

In the end, from 1,653 papers, 52 were included by both collaborators to a list to read and 38 papers were in conflict as shown in figure 2. To solve that problem, another researcher was invited to participate as a reviewer in the selection to help collaborators in the end of mining. From 38 texts in conflicting opinions by collaborators, 12 were included in the list of texts to read and the rest were excluded.

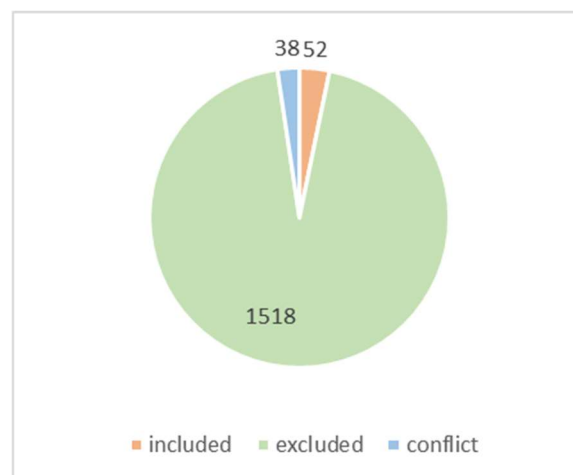


Figure 2: Results obtained in Rayann after collaborators analyze.

From 64 articles included in the research, their distribution is shown on figure 3. It is possible to see that TOG methodology search begun in the seventies after the beginning of the first UNEP in 1972 in Stockholm. Then, in 1996 an increase of studies is observed in the figure 3, which coincides to United Nations Conference on Environment and Development in Rio de Janeiro.

After that, another increase in 2011 is observed again, probably due to new regulations controlling TOG measurement around the world between the nineties and the first decade of this century. Furthermore, Rio+20 conference took place in 2012, that launched the platform on biodiversity, where it is possible to know confident information on public policies on this matter.

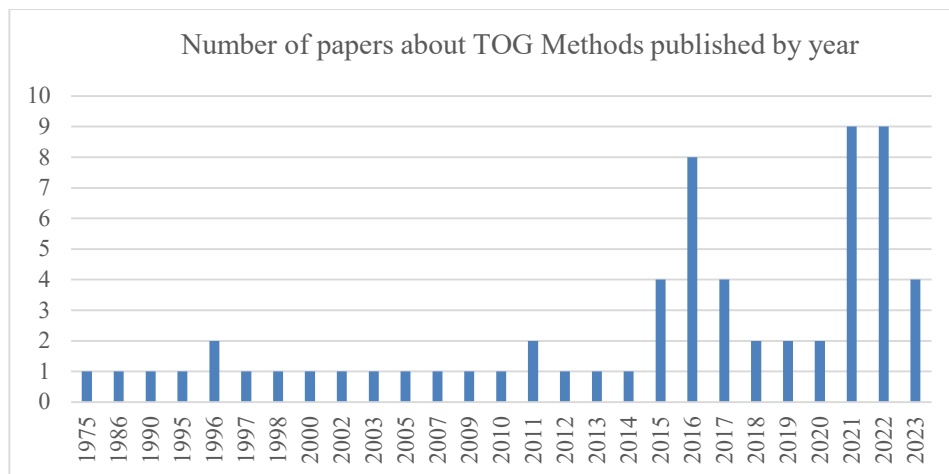


Figure 3: Papers published by year since 1975 after mining and discussion about conflicts.

In figure 4, it is also possible to notice the exponential growth through decades. In the first two decades it is seen a beginning not so relevant, probably due to a shy movement of concern about environment and climate. As this concern has grown up, interests or requirements to investigate or learn more about the subject accompanied this growth.

It looks that the world has woken up. The environment protection and concern about climate changing is linked to human survival. But before that, the world already knew the relationship between air, water, and environment since it was observed health injury related to presence of lead in fuels by Clair Patterson in the forties.

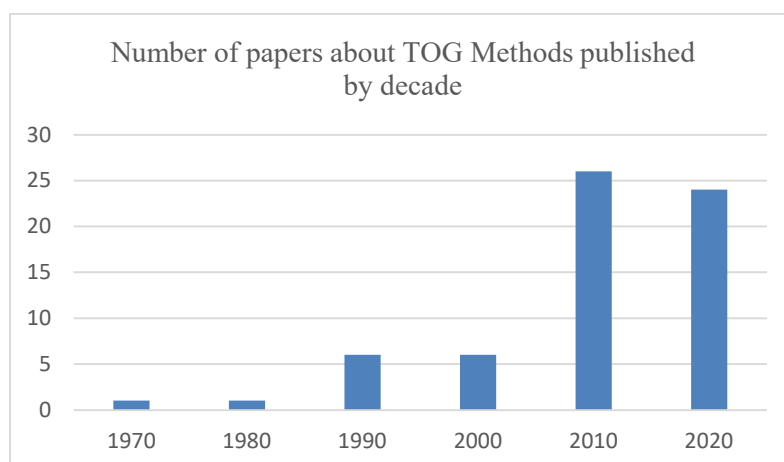


Figure 4: Number of papers found in search and published by decade.

4. Discussion

Try to find a single reason for an interest exponential increase in studying environmental impacts and methods for measuring them would be to oversimplify something that is so complex. There are multiple reasons for that.

To make the discussion simple, the analysis will be carried out for decades and the events that influenced the changes in society's attitude towards the environmental issue and its mirroring in scientific articles.

In 1970's and 1980's, the world began to worry about environmental issues, but not to the point of developing public policies linked to water pollution by oil production. That can be noticed for the number of papers identified in this search for that period.

In Brazil, Stockholm Conference influenced the ecological conscience, which was spread in legislation. Two legislative frameworks emerged from that: the National Environmental Policy (1981), that ensure the "maintenance of the ecological balance, considering the environment as a public asset to be necessarily ensured and protected, with a view to collective use" and the regulation of public civil action of responsibility for damages caused to the environment, allowing the collective access to the Justice for the defense of the environment. [9]

In the end of 1980's, Chernobyl accident showed to the world that dangers brought with modernity and the so-called risk society, amalgamated nature and society, there are no more borders for danger. It is not just errors that can bring catastrophe situations, but the systems that turn human errors into forces of destruction. Assessing hazards has become more important, and for that, measuring instruments, new measurement methods are needed [10].

The Federal Constitution of 1988 transformed the healthy environment into a good protected by the legal system and a fundamental right of the individual [9].

In 1992, took place ECO-92, in which commitments were established to control CO₂ emissions in the atmosphere and adoption of procedures for the protection of water resources and management of toxic waste, among others [11].

It was the beginning of some important public policies in some countries and its interest can be seen in figures 3 and 4 by the number of papers published found in this research.

In the following decade, Rio+10 took place in South Africa, where several policies were ratified. The general risk of climate change speaks to a production of risk perceptions and regulatory horizons. This change is the materialization of the errors of industrialization that occurred over the last few centuries, whose abstract concepts have been treated as unimportant objects as a particular form of alienation from this mode of production [12].

In 2009, COP 15 showed a notorious disconnection between social expectations, based on the predictive capacity of climate science, and the political disappointments resulting from the conference [11].

In Brazil, the National Solid Waste Policy established the obligation of processing waste before disposal and the government decided to share the responsibility of environment conservation between Union, states, and municipalities [12]. In 2010's, the first papers produced by Brazil in the search for determination of TOG were identified due an enforce in new public policies specially by Conama to regulate the oil and gas production. From 26 papers identifies in 2010 decade, 8 were written by Brazil, that reflects the oil and gas importance to trade balance and GDP (gross domestic product) to the country.

At COP 27 in 2022, 150 countries committed to sustainable development goal (SDG) 14, linked to the conservation and sustainable use of oceans, seas, and marine resources.[13]. That last 4 years from 24 papers identified, 7 were from Brazil.

But something could be seen in the pandemic period, seas have become cleaner, air pollution has decreased a lot in large cities. This occurred precisely in a period of reduced production and consumption of fossil fuels, among others.

5. Conclusion

In this scoping review, it was noticed how research on methods to determine TOG in water has been developed over the last 50 years in the world and in Brazil. It is also possible to notice how public policies and government guidelines for society boosted research and how research in the climate area boosted public policies and global decisions at the same time.

However, it is observed that in practice this improvement has not been perceived in populations lives, despite the design of new public policies and technological development. It would be important that governments encourage more research in alternatives fuels, but also to improve the production of current used fuels, since a change of this magnitude cannot be carried out at the necessary speed.

That is why this work propose to develop a new methodology faster and cheaper than what is found nowadays.

References

- [1] UNITED NATIONS Environmet Programme. *Marcos Ambientais: linha do tempo dos 75 anos da ONU*. Available in: <https://www.unep.org/pt-br/news-and-stories/story/environmental-moments-un75-timeline>. Accessed in 06/10/2023.
- [2] Silva, C. M. F.; Silva, E. D.; Melchuna, A.; Arinelli, L.; Hori, E. S.; Lucas, E. F. 2022. *Ind. Eng. Chem. Res.* **61**, 18243-18249.
- [3] CONAMA, C. N. do M. A. 2007. *Resolução N° 393*; Min. do Meio Amb. Brasil.
- [4] OSPAR's Commission. 2022. *Ospar Offshore Industry Committee: fact sheet 2022*. Produced water discharges from offshore oil and gas installations 2009-2019. **906** (Ospar Publications), p. 1-2.
- [5] YANG, M. Measurement of oil in produced water. In: *Produced water*, Springer: New York, 2011; DOI:10.1007/978-1-4614-0046-2_2.
- [6] Zachary, M.; Pollock, D.; Khalil, H; Alexander, L.; McInerney, P.; Godfrey, C. M.; Peters, M.; Tricco, A. C. 2022. *Joanna Briggs Institute Evidence Synthesis*. What are scoping reviews? Providing a formal definition of scoping reviews as a type of evidence synthesis. **20** Adelaide (JBIES), p. 950-952.
- [7] Page, M.J. McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. 2021. *BMJ*; **372**: n71. doi: 10.1136/bmj. n71.
- [8] Sanches, K. S.; Rabin, E. G.; Teixeira, P. T. O. Cenário de publicação científica dos últimos 5 anos sobre cuidados paliativos em oncologia: revisão de escopo. 2018. *Rev Esc. Enferm. USP.* **52**e:03336. Doi:10.1590/S1980-220X2017009103336. Accessed in: 01/07/2023.
- [9] SILVA, Railma Marrone Pereira. O meio ambiente na Constituição Federal de 1988. 2013. *Rev. Jus Navigandi*, ISSN 1518-4862, Teresina (18), n. 3759. Disponível em: <https://jus.com.br/artigos/25529>. Acesso em: 17 jul. 2023.
- [10] Beck, U. *Sociedade do Risco: rumo a uma outra modernidade*. 2010. São Paulo (Ed. 34). 368 p.
- [11] Borges, L. A. C.; Rezende, J. L. P.; Pereira, J. A. A. Evolução da legislação ambiental no Brasil. *Rev. em Agronegócios e M. Amb.*, v. 2, n. 3, p. 447-466, st/dez 2009. Available in: <file:///C:/Users/Samsung/Downloads/1146-Texto%20do%20artigo%20-%20Arquivo%20Original-3504-2-10-20160623.pdf>. Accessed in: 10/07/2023.
- [12] Beck, U. *A metamorfose do mundo: novos conceitos para uma nova realidade*. 2018. Rio de Janeiro (Ed. Zahar). 279 p.
- [13] <http://www.iri.puc-rio.br/blog/governanca-global-do-meio-ambiente-um-resumo-das-conferencias-ambientais-de-2022-e-o-que-vem-em-2023/>. Accessed on 07/10/2023



Acknowledgements

The authors thank the Brazilian National Council for Scientific and Technological Development (grant 307.562/2020-4 [RCF]) and the Research Support Foundation of the State of Rio de Janeiro (grant E-26/210.687/2019, E-26/211.170/2019, and E-26/201.153/2021 [RCF]).