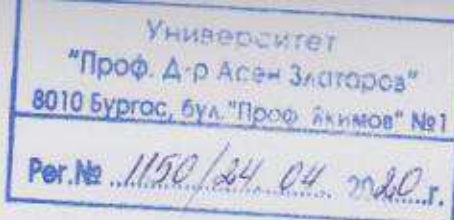


## Review



By Prof.Dr.Stoyko Petrov

Of the competition for the occupation of the academic position “associate professor” in the professional field 4.4 “Earth sciences”, scientific specialty 02.22.04.

„Technology for utilization and treatment of wastes: (Utilization and treatment from the wastes from biodiesel production)

**Grounds:** the competition was announced in State Gazette issue 1/3.01.2020 by University “Prof.Dr.Asen Zlatarov”, Faculty of natural sciences, for the Department of “Ecology and environment protection. Application documents for the competition have been submitted by senior assistant Dr. Nikola Stoyanov Todorov. The present review was elaborated in pursuance of the order of the Rector of University “Prof.Dr.Asen Zlatarov” № RD – 64/04.03.2020 and selection of reviewer carried out during the first session of the scientific jury held on 06.03.2020 г.

### 1. Biographical data

Senior assistant Dr. Nikola Stoyanov Todorov is the only candidate for the competition for the academic position of “assistant professor”. He was born on 25.10.1983 in Bourgas. He graduated the English language school “Geo Milev” in 2003. He was granted bachelor’s degree in the specialty of “Tourism” obtained in 2007 and master’s degree in the specialty of “International business” of the Faculty of social sciences of the University “Prof.Dr.Asen Zlatarov”. In 2011, he was granted master’s degree in the specialty “Ecology and environment protection” of the FNS of the University “Prof.Dr.Asen Zlatarov”.

He has worked for two years as an operator in the Central scientific research laboratory of the University “Prof.Dr.Asen Zlatarov”. During this period he learned the methods of research of chemical compounds on XRD apparatus IRIS M, UV-VIS spectrophotometer, Evolution 300 UV VIS and FT IR spectrophotometer Nicolet iS 50 FT IR. This helped him accumulate knowledge about the analysis and interpretation of the characteristics of different chemical compounds using the corresponding instrumental methods of analysis.

In February 2012, he was enrolled in full-time as doctorate applicant at the Dept. of “EEP”. He defended his doctorate in January 2015 in the specialty accredited to the Faculty of technical sciences “High molecular weight compounds within the specified 3-year term.

The topic of his PhD thesis was “Utilization of waste polyethylene terephthalate”. He published 4 papers in the topic of the doctorate, two of which in English language (in the journals „*International Journal Of Scientific Research, Environment Science*“ and *Journal of International Scientific Publications: Ecology & Safety*“) and 2 in Bulgarian language (in the Annual of the University and in the Proceedings of „*Science & Technologies*“ conference.

On June 1<sup>st</sup>, 2015 he was elected as assistant at the Dept. of "EEP" and on July 13<sup>th</sup> was elected as Senior assistant which is his position until now.

He has very good command of English and German languages.

## **2. Compliance with the Minimum State and University scientometric indicators for the academic position of "assistant professor"**

The set of materials presented complies with the requirements of the Law on the development of the academic staff in the Republic of Bulgaria and the Rules for the application of this law. For the participation in the competition, N.Todorov submitted the following scientific publications: PhD thesis and individual monography reporting for studies which have not been used in scientific publications. -150 pts. Publications / 3 pcs./ in referred and indexed in world-known databases with scientific information (Scopus; Web of Science)-86 pts. Publications in non-referred journals with scientific reviewing, abroad / 5 pcs./ and in Bulgaria -/ 18 pcs./ . He is the only author of four of them. Of these publications, he is the first author in four papers and first author in 10 joint publications – 270 pts. There are also 38 citations and reviews -100 pts., two textbooks - 60 pts. And 3 projects -40 pts. This makes a total of 693 pts which complies with the national /400 pts./ and University /650 pts./ requirements towards he candidate. The publications and the scientific announcements presented correspond to the code of the competition.

## **3. Assessment of the teaching activities**

His teaching experience together with the period of the competition is more than 5 years. It can be seen from the information about his workload (№9) during the last three years as Senior assistant, PhD, that he has held exercises and lectures on the subjects of "Protected areas", "Ecologic legislation and regulations" and "Air pollution and impact on the ecosystems". He has developed or updated a total of 7 (seven) curricula on the subjects of "Protected areas", "Ecologic monitoring", "Ecologic legislation and regulations" for the specialties "Ecology and environment protection", "Ecology and ecological management" and "Ecologic legislation and regulations" for the specialty "Chemistry of the cosmetics and surfactants" (List №16 and Addendum IV). There are no students yet trained in the last curriculum.

During the subsequent 3 academic years in the period 2017 – 2020, his teaching load was 372 h (93 h lectures), 394 h (134 h lectures) and 545 h (230 h lectures), respectively (item 9 of the Documents). It can be seen from the certificate presented (№10) that he has also conducted exercises with international students: 4 students from Kazakhstan in the subject "Ecologic monitoring" during the academic year 2017/2018 and lectures and exercises with one student in the subject "Geoecology" during the academic year 2018/2019.

N.Todorov actively works with students and graduates. As can be seen from the information in item 17, 5 graduates have successfully defended their diploma theses under his guidance of co-guidance. He has worked with 9 group members on 2 projects. The group members participated with reports in 8 scientific forums: Scientific session

for students, PhD applicants and international scientific conferences – Stara Zagora. The group members mentioned in the list became co-authors of 3 publications, two of which abroad and one in the Annual of the University.

He is author of the textbook “Ecologic monitoring” and co-author of the textbook “Protected areas”.

#### **4. Scientific research and publication activities**

The scientific research activities of N.Todorov was realized in the fields of “Utilization and treatment of wastes from biodiesel production”, “Ecologic monitoring” and “Study on the structure of some organic compounds or polymers by instrumental methods of analysis”.

The candidate has participated in 8 scientific research projects within the Scientific Research Sector of the University: 1 national, granted by the Scientific Research Fund of the Ministry of education and science, 6 intra-institutional contracts (NIH) and 1 contract “Services” assigned by “Dekor Design” PLC. He was head of the tem for 3 of the contracts (2 by NIH and 1 services). Three of the contracts are exactly in the field of the present competition.

Only part of the scientific research work of the candidate corresponds to the code of the competition. These are the scientific works in the fields of “Utilization and treatment of wastes from biodiesel production” and only they are subject of review. In this field, the candidate submits 1 monographic work and 15 publications. The results from the studies reported in 7 publications are presented at international scientific conferences.

##### **4.1 Monographic work**

The monograph is individual scientific research effort related to the “Utilization of the glycerol phase” produced as side product by the biodiesel production from rapeseed oil. The results presented in the monograph had not previously been published in other scientific papers.

The actuality of the topic is in accordance with the fact that only in Europe more than 1.2 mln tons of glycerol (crude, as glycerol phase) are annually generated from which 55% comes from processing of rapeseed oil. The glycerol phase should not be disposed in the environment due to its harmful composition: pH = 9-12; high content of soaps and methyl alcohol.

The literary review describes the main contributions and disadvantages of the processes of controlling the glycerol phase, its composition and characteristics, the necessity for its modification which can make it possible to utilize the waste products until valuable secondary materials /alkyd resins/ with optimal physicochemical properties are obtained. For this purpose, it is necessary treat by such methods which would help, on one hand, to simplify its composition and on the other hand – to generate no other harmful substances.

The composition of the fatty acids present in the rapeseed oil is quite suitable for production of biodiesel (iodine value less than 125 gI<sup>2</sup>/100g which ensures its good

thermal stability) but is big disadvantage when alkyd resins are prepared for which the drying ability of the alkyd resins depends on the iodine value.

These two problems determine the main goals and tasks which should be realized to utilize all the organic substances contained in the glycerol phase.

The experimental studies involved the use of many chemical methods of treatment saponification and neutralization of the glycerol phase, synthesis of alkyd resins by the method of fatty acids and alcoholysis, esterification, application of relevant methods and standards for studying the resins and the possibilities for their use for various purposes. Both standard and modern physicochemical methods of analysis were used to characterize the products.

The main results can be grouped in as follows:

It was found that the glycerol phase obtained as side product from the biodiesel production from rapeseed oil can be used as raw material for production of alkyd resins although these resins can dry at temperature  $\geq 130^{\circ}\text{C}$  and can only be used as primers where the requirements towards color and physicochemical properties are not so strong.

A possibility to improve the alkyd resins' drying ability by modification with maleic anhydride was found which widens the range of the glycerol phase application for production of air drying paints and lacquers.

For the first time alkyds were obtained by simultaneous utilization of two waste products – PET from beverage bottles and the glycerol phase. The joint neutralization of two waste products obtained from different technological processes or social activities is a new direction in wastes management. The alkyd resins modified with PET showed improved drying ability and chemical stability and these properties were inherited from the two different by nature materials.

The influence of microwave irradiation during the processing was investigated by which reduced costs and shorter processing time was achieved.

All this makes the monograph a complete individual study which is ecologically and scientifically practical.

#### **4.2. Utilization of crude glycerol**

The author carried out PET depolymerization with crude glycerol without catalysts /11/. As a result from the depolymerization, precursor monomers, dimers and oligomers were obtained which was proved by the method of material balance, UV spectroscopy [12] and non-isothermal decomposition [14]. A technology for achieving high degree of depolymerization was suggested [9].

Results are presented for the possibility to use the products obtained for synthesis of unsaturated polyester resins, polymer concrete /13/ and alkyd resins. One of the scientific fields by the preparation of unsaturated polyester resins is the use of maleic anhydride in the process. These products possess insufficient compatibility with styrene. To improve this compatibility, propylene glycol was used. It was proved that the resin has better characteristics when the glycol was introduced during the process

of depolymerization /10/ rather than during the process of esterification with maleic anhydride /4/.

The possibility to substitute part of styrene with methyl methacrylate aiming to reduce styrene toxicity was proved /6/.

For the synthesis of the alkyd resins, PET depolymerized with phthalic anhydride /1/, mixture of sunflower and flax oils were used /7/. It was found that with preliminary separation of the water soluble and water insoluble fractions [1] alkyd resins and hardened products of better quality were obtained. The resins synthesized had properties close to these of the standard resins and even showed higher hardness.

#### **4.3. Utilization of the glycerol phase obtained from biodiesel production**

The utilization of the glycerol phase is more complicated task. The glycerol phase is multicomponent and the components vary in wide range. The author established that the most suitable method for glycerol phase treatment is to carry out sequential processes of saponification and neutralization. As a result, two products were obtained – crude glycerol and fatty acids. These two products were used to obtain monoglycerides /5/, depolymerization of PET /8/ and synthesis of surface coatings /2/.

The main contributions among these studies are as follows:

- the optimal conditions for obtainment of monoglycerides: ratio crude glycerol / fatty acids = 1,5 and duration 60 min in presence of catalyst KOH (0,1wt. %)/5/.

- For the first time, a study of the products of PET depolymerization with monoglycerides was carried out /8/. Using the methods of gel permeation chromatography, FTIR and UV-spectroscopy, and comparing the products of PET depolymerization with oleic acid /15/, it was proved that mainly precursor dimers are obtained.

- It was found that alkyd resins can be synthesized by esterification of phthalic anhydride and the product of PET solvolysis with monoglycerides. The films prepared from the alkyd resins obtained were proved to excel the reference ones with respect to degree of drying and hardness.

#### **4.4. Scientific publications and citations**

All the publications related to the topic of the competition are focused on the utilization of crude glycerol or of all the organic substances in the glycerol phase by using them as initial materials for synthesis of alkyd or unsaturated polyester resins. Simultaneously, another waste product is utilized – waste polyethylene terephthalate (PET) from beverage bottles.

Two of the scientific publications of Dr. Nikola Todorov are in referred and indexed in world-known databases with scientific information (Scopus; Web of Science), namely these published in *Journal of Chemical Technology and Metallurgy* and *Bulgarian Chemical Communications*. Five of the publications are published in non-referred journals with scientific reviewing from abroad (*International Journal of Scientific Research*, *Environmental Science*, *International Journal of Applied Research*, *Indian journal of Applied Research*) and the other 8 are published in the

Annual (2 pcs.) and in proceedings of conferences held in Bulgaria, as follows: International Conference Education, Science, Economics and Technologies(4 бр.), International scientific conference Stara Zagora (1 pc), International Conference *Ecology & Safety* (1 pcs),

N.Todorov presents also information about 37 citations of 15 papers and 1 review (item 12.3). There are no self-citations. According to the author's verification made in February 2020 in Scopus (item 12.4) H index = 2 and 3 documents have total of 6 citations.

It should be noted that publication /1/ is cited 9 times among which there are citations in journals referred and indexed in world databases with scientific information (Scopus; Web of Science )

One publication [7] printed in the International Journal of Applied Research was cited in USA patent US10479859B2.

Among non-reviewed publications, the highest number of citations (5) has paper [3]. Three of the citations are with IF and SJR

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the author is reviewer of a publication in the referred and indexed in Scopus scientific magazine „Journal of Coatings Technology and Research“, ISSN 15470091, IF 1.584.

#### CONCLUSION:

All the materials presented, documents and results entitle me to give positive assessment of the scientific research and teaching activities of Senior assistant Dr.Nikola Todorov. I suggest to the scientific jury to give positive assessment and to suggest to the Faculty council of the FNS to award Dr.Nikola Todorov the academic position of “associate professor” in the professional field 4.4. „Earth sciences”, scientific specialty 02.22.04. „Technology for utilization and processing of wastes“ (Utilization and processing of wastes from biodiesel production)

15.04.2020 г.

Reviewer  
/Prof.Dr.Stoyko Petrov /