Cloud Computing for Maritime Education

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Abstract

The firs place in the list of the most important "IT- revolutions" belongs to development of so-called "cloud computing" – providing of remote computing ability, footprint ("clouds") and communications channels for customers. The reason which begets using of "cloud computing" is high cost for program licenses for detached workstations, rent of space, electricity and control of software piracy. By "clouds" we mean computing centers which are significantly more powerful than user's stationary infrastructure. Instead of physical servers customers use virtual servers which are spread in allocated net of computers with industrial ability.

For providing of "cloud computing" for energy sector of national economy in Moscow Power Engineering Institute (Technical University) there was created a server which allows opening documents which were created in MathCAD engineering calculator.

"Cloud" computing can be widely adopted in educational system and particularly in sphere of Maritime Education. It permits not only to increase the quality of education, but also to create international educational programs. In this paper we describe the results of the joint work of the Far Eastern National Technical University, the Moscow Power and Energy Institute and the State Marine Technical University of St. Petersburg in sphere of creation of maritime educational programs based on "cloud" computing.

Keyword: *educational system, marine technologies, "cloud" computing*

1. Introduction

One of the parts of calculation site is the data base of chemical-engineering composition of water supply sources of Russia, countries of CIS and the Baltic. User of site chooses required source from the list, presses button "Recalculate" and receives data about chemical composition of water in the concrete source, engineering characteristics of water and a pie diagram with cationic and anionic composition.

Thermal physical and some of physicochemical characteristics of water are calculated with help of formulas which are designed and confirmed by International Association for the Properties of Water and Steam (www.iapws.org). Some of its pages calculate physicochemical characteristics of water and solutions.

By input of need value of temperature and pressure and pressing button Recalculate user of the site will receive not only value of pKw, but also all intermediate data of computing. It will allow to create the present computing, for example, in tabular processor Excel and, which is the most important, will help to debug it in a short time when having all intermediate control data. The operating point is fixed on p-T diagram.

In September 2008 on the annual session of IAPWS there were confirmed formulas for thermodynamic characteristic of seawater, which were designed during many years. And at once there was opened the Internet-site where it is possible to calculate this characteristic in interactive regime.

User of the site can change the input values of salinity of water, its temperature and pressure and receive data of thermodynamic characteristic of seawater. In this case, as in the case of calculation of Kw of pure water, all used formulas (with intermediate data) are shown. In addition, calculated point is fixed on the graphic so that user can see certain “dynamics” of the parameter – its change when change if input values.

The describable computing site for chemists - power engineering specialists possess many simple and routine calculations which though take a lot of work time of engineers of chemical departments of thermal and nuclear power plants.

2. Physical quantities, dimensions and units of measurement in “cloud” calculation system

Today every specialist in every field of science and technique can exemplify a lot of mistakes connected with erroneous handling with physical quantities, dimensions or units of measurement. Conversion from manual calculations to computer programming languages had not solved this problem completely.

But it is possible to avoid such mistakes by the correct programming of the calculation programs.

Mathematical software packages which are equipped with means of operating with physical quantities (Mathcad, Maple, Derive etc.) accelerate the process of creation of computer calculation programs through automatic recalculation of units of measurement and control of dimensions of variables and functions. This thesis is illustrated on Fig. 1 [7] by the concrete example of solution of the task about facility of the pump transmitting an incompressible liquid in Mathcad.

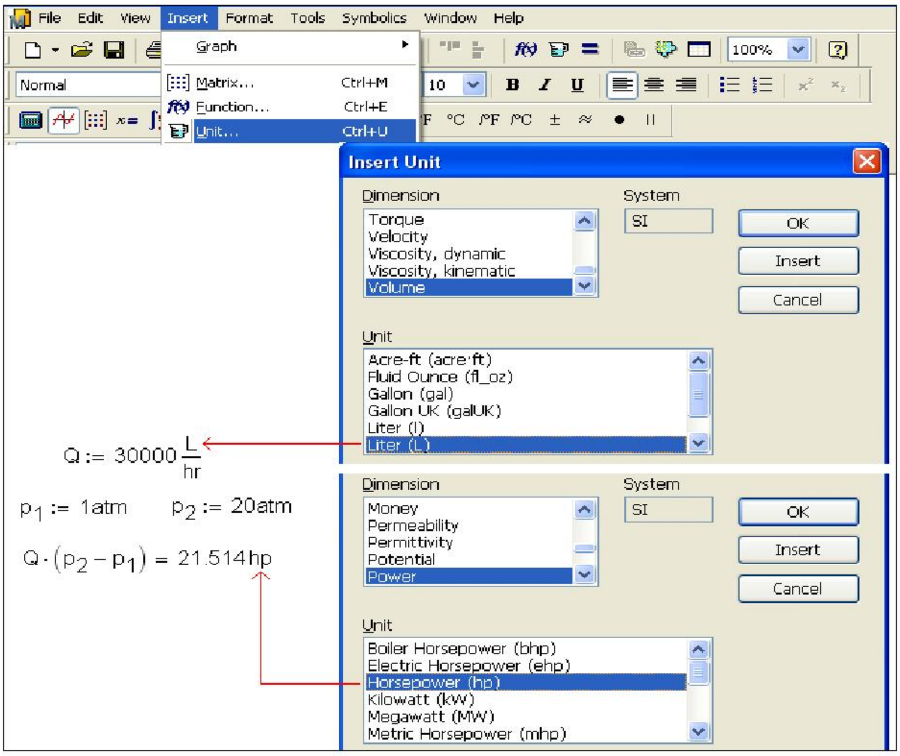

Fig.1. Calculation of pump facility in Mathcad

Here is a real thermodynamic task, and when its solution in Mathcad it will be necessary (or al least it will be advisable) to operate with different physical quantities which have the same dimension (in this case it is mass).
We need to calculate the coefficient of thermal efficiency of a steam-to-gas heat-and-power engineering cycle. For this purpose it is necessary to operate with functions which recover thermodynamic behaviors of a working substance. These functions can be provided with help of WaterSteamPro program package – fig. 10.
Fig. 10 [5] illustrates the way of calculation of water boiling temperature at given pressure by call of one of functions of WaterSteamPro package - wspTSP function. Meanwhile all quantities still are dimensionless, it is purported that pressure is expressed in pascal, temperature is gauged by Kelvin scale (expressed in kelvin). All functions of WaterSteamPro package operate with dimensionless arguments and call dimensionless quantities, which conforms to basic units of measurement in SI: meters, kilograms, joules (but not kilojoules), pascals (but not megapascals) etc. [3, 4]
Butmathematical program Mathcad is equipped by instruments for operation with dimensional units, and this mechanism must be used in solution of our task about steam-to-gas cycle and generally in heat-and-power engineering calculations.

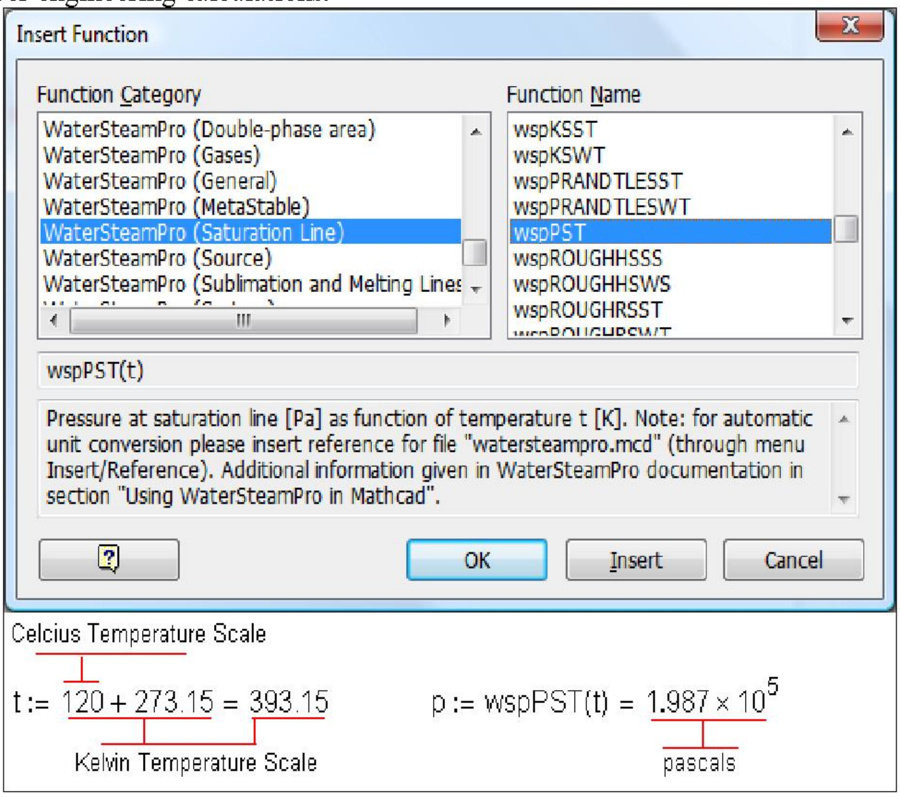

Fig. 2. Functions of WaterSteamPro package in Mathcad environment

For performing the functions of WaterSteamPro package as a dimensional functions it is necessary to make a link in concrete Mathcad document to the watersteamprio.mcd file which is built-in WaterSteamPro package – fig. 3.

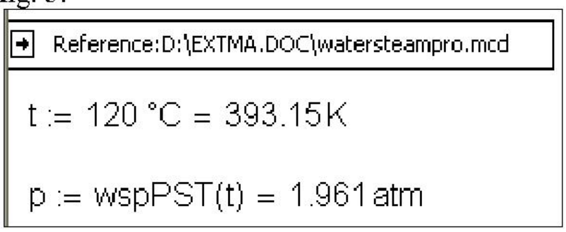

Fig. 3. "Dimensional" functions of WaterSteamPro package in Mathcad

First, it contains operators which implement the national dimensions into the calculation and different constants which are required for heat-and-power engineering calculations (universal gas constant, temperature and pressure of triple and critical points of water and water steam etc.). Second, and main, watersteampro.mcd file contains operators which turn dimensionless functions of WaterSteamPro package into dimensional in Mathcad environment.

But there is another way [5] – not to create link to file warwesteampro.mcd which redefines all functions of the package, but to insert operators which redefine only some of the functions which are necessary for the concrete thermotechnical calculation, taking in consideration the thesis which says that certain different physical units have the same dimension. Particularly, in our task about thermodynamic efficiency of steam-to-gas cycle there will be two different physical units – mass of gas and mass of water / water steam, which have the same dimension of mass.

$$kgg := cd \qquad J/kgg := \frac{J}{kgg} \qquad J/(kgg\ K) := \frac{J}{kgg\ K}$$

$$wspgHGST(gas\_specification, t) := wspgHGST_{[user]}\left(gas\_specification, \frac{t+K}{K} - 1\right) \cdot J/kgg$$

$$wspgSGSPT(gas\_specification, p, t) := wspgSGSPT_{[user]}\left(gas\_specification, \frac{p+Pa}{Pa} - 1, \frac{t+K}{K} - 1\right) \cdot J/(kgg\ K)$$

$$wspgTGSPS(gas\_specification, p, s) := wspgTGSPS_{[user]}\left(gas\_specification, \frac{p+Pa}{Pa} - 1, \frac{s + J/(kgg\ K)}{J/(kgg\ K)} - 1\right) \cdot K$$

$$kgws := kg \qquad J/kgws := \frac{J}{kgws} \qquad J/(kgws\ K) := \frac{J}{kgws\ K}$$

$$wspHPT(p, t) := wspHPT_{[user]}\left(\frac{p+Pa}{Pa} - 1, \frac{t+K}{K} - 1\right) \cdot J/kgws$$

$$wspSPT(p, t) := wspSPT_{[user]}\left(\frac{p+Pa}{Pa} - 1, \frac{t+K}{K} - 1\right) \cdot J/(kgws\ K)$$

$$wspPST(t) := wspPST_{[user]}\left(\frac{t+K}{K} - 1\right) Pa$$

$$wspXSTS(t, s) := wspXSTS_{[user]}\left(\frac{t+K}{K} - 1, \frac{s + J/(kgws\ K)}{J/(kgws\ K)} - 1\right)$$

$$wspHSTX(t, x) := wspHSTX_{[user]}\left(\frac{t+K}{K} - 1, x\right) \cdot J/kgws$$

$$wspHSWT(t) := wspHSWT_{[user]}\left(\frac{t+K}{K} - 1\right) \cdot J/kgws$$

$$wspHSST(t) := wspHSST_{[user]}\left(\frac{t+K}{K} - 1\right) \cdot J/kgws$$

$$wspSSWT(t) := wspSSWT_{[user]}\left(\frac{t+K}{K} - 1\right) \cdot J/(kgws\ K)$$

$$wspHPS(p, s) := wspHPS_{[user]}\left(\frac{p+Pa}{Pa} - 1, \frac{s + J/(kgws\ K)}{J/(kgws\ K)} - 1\right) \cdot J/kgws$$

Fig. 4. Overloading of certain functions of WaterSteamPro package

In the calculation which is shown on fig. 4 there is not only concretization of kilogram (kgg and kgws) but control of correct work with physical quantities (enthalpy, entropy). Thou at the end of calculation there are two emergency stops (difference of enthalpy of work cycle in point 1 and point 6 and sum of specific work of gas and steam turbines).

In the absence thereof physical quantities with mass dimension (fig. 3) there would not be any emergency stops in these operators, which could cause errors in calculations with different consequences (examples are described at the beginning of the text).

Real combined-cycle plant (but not ideal as in our task) there are more than two working substances. Alongside with steam and air it is necessary to take into account thermodynamic properties of fuel which is directed to combustion chamber of gas turbine (natural gas of different chemical composition, combustion products etc.). Therefore it is better to use more than two (kgg and kdws) units of mass and the other units of measurement. [1, 2] Dialog box in the right lower corner (fig. 5) is our wish to creators of the following versions of engineering calculators.

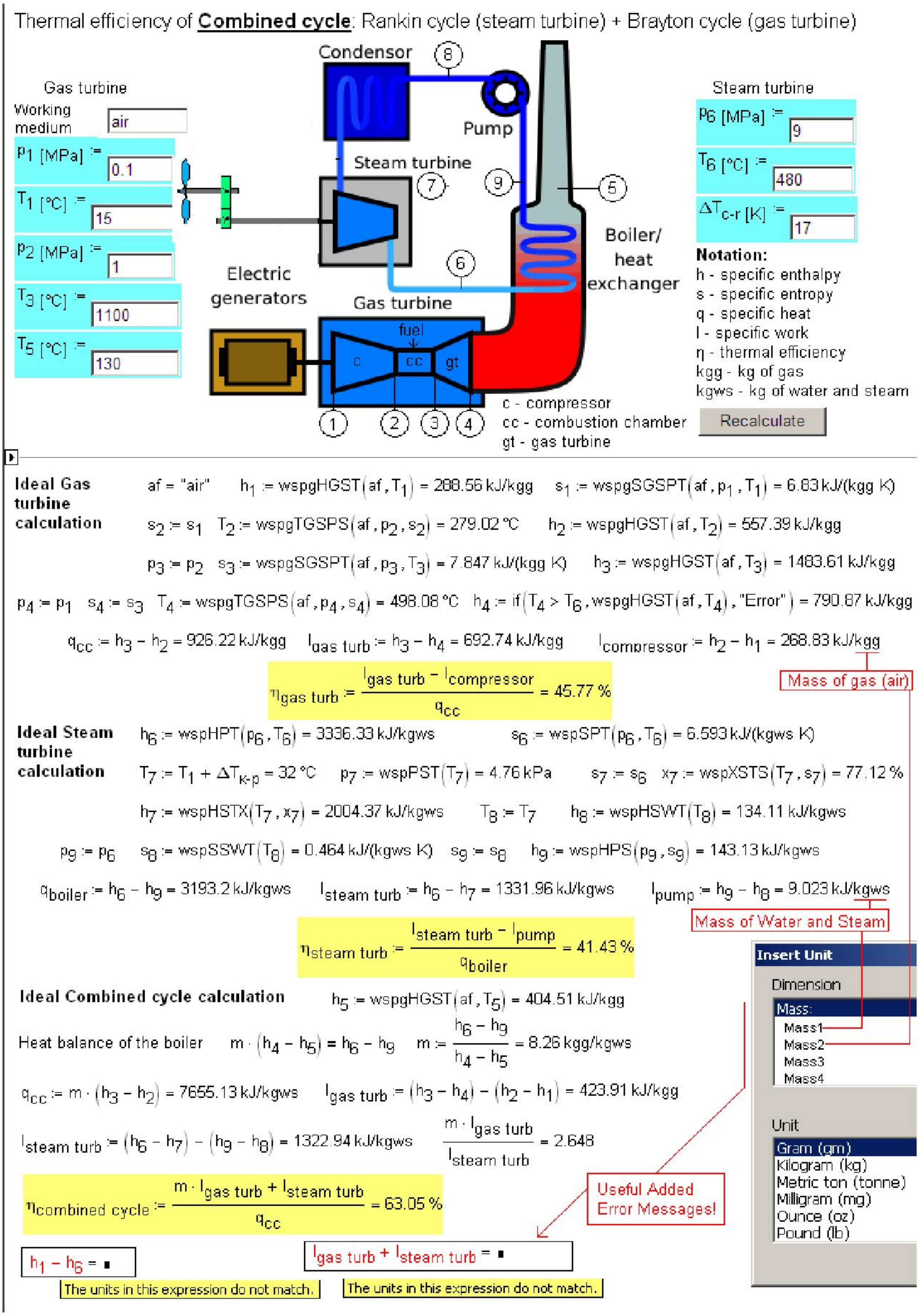

Fig. 5. Calculation of steam-to-gas cycle

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