The Process of Management for the Treatment and Reuse of Water through Decantation
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Abstract
Water treatment and its reuse process has gaining space specially in large urban centers where scarcity represents high investments and running costs for water harvesting and abduction at large distances. The present article describes how the civil construction industries realize the water treatment and its reuse process applied in their production. The aim of this article is to make the industries aware to treat and to reuse water present in their production through decantation, a viable and very much used resource currently assumed by companies. The methods and techniques employed in the research field were: documental analysis, interview and direct observation where collected and analyzed data were tabulated and reviewed in several sectors of the company as: management, supervision, management of quality and production laboratory. The results consisted on conscious consumption of water, in most rigorous controls to the means used in its treatment and reuse. By adopting that treatment and reuse management process the company will save around 70% to 80% of that water reuse and a saving in the energy bill since the new technology that is applied in the processes of decantation will guarantee a good quality water with low energy consumption bringing economic, social and environmental benefits.

INTRODUCTION
In this article we will observe how it is the water treatment and its reuse employed in the production in industries of concrete. The treatment of water in industries by decantation is a process of recovering the quality of water used in the industry (Cintra, 2012). By the treatment and reuse of water social, environmental and economic benefits take place and it all just happens on account of a process called decantation that is of great importance because it has great position in the company (Minowa, 2010). This research is characterized as a study case of descriptive and qualitative nature. According to Cervo, Bervian (2011), “this kind of research takes place when facts ad phenomena are registred, analyzed and correlated without manipulating them “. By collected data it was possible to observe the result of the research and to identify the shortcomings in the water treatment and reuse process in the company. Data were tabulated to comprehend it best. In accordance with Gil (2011), “The data collection helps to analyze point to point the facts and the phenomena which are taking place in a company being the start point for the elaboration and execution of a work”. The study took place at SUPERMIX CONCRETO S/A company where it was possible, by the research made there, to observe shortcomings in environmental field principally in the use of water that is the main input in the company. The use of water requires an advanced planning to guarantee its permant availability what means to implement its “sustainable use” because the civil construction is a large consumer of water and each new work or reformation they use liters of water to mixture the aggregates with cement composing the concrete mass (Salama, 2012).

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LITERATURE REVIEW

Reuse of water
To Lavrador (2012), “In Brazil despite the apparent abundance of hydric resources, the reuse of water is gaining space mainly in large urban centers where scarcity represents high investments and running costs for capture and adduction of waters at large distances. To the application of reuse in industrial processes it has been given special attention to the quality of waters at question and the potential effects in the health of users in industrial installations: like corrosion, inlays and deposition of solid materials into pipes, tanks and other equipments besides the nocive effects to the productive processes as alterations of reagents solubility in the processing steps and alterations of physical and chemical characteristics of final goods (Lavrador, 2012).

Minowa affirms (2010), “Reuse and the water recycling in industries leads to constitute, therefore, fundamental tools of management for the sustainability of industrial production”. On that issue Minowa still affirms that (2010): water reuse brings out many benefits as follows:

Environmental benefits:
Reduction of industrial effluents release in watercourses making possible to improve the quality of inland waters of more industrialized regions:
- Reduction of surface and ground water catchment allowing a more balanced ecological situation;
- Increase of water availability for more demanding use as public and hospital supply etc.

Economic benefits:
Environmental compliance in terms of patterns and established environmental regulations allowing a better insertion of Brazilian products in international markets:
- Changes in production and consumption patterns;
- Decrease in running costs;
- Increase of sector competitiveness;
- License to receive incentives and reduce coefficients from collecting factors of water use.

Social benefits:
Expansion of business opportunities to providing service companies and equipment in the whole production chain:
- Expansion at direct and indirect job creation;
- Improvement in the productive sector to the society by the recognition of socially responsible companies.

Water treatment by decantation
Water is essential to beings for that reason it should have a pure and clean aspect. Often to achieve that goal it is necessary to recover its quality through a treatment system. Water treatment is a physical and chemical set of procedures that are applied so that the liquid be in proper condition to be consumed. Currently we find several procedures to water and affluents treatment and one of them is the decanting system (Di Bernardo; Dantas, 2005).

To Cintra (2012), “water treatment through decantation is a water recovering process in industries. Water treatment must be supervised by a professional of that specific field, like a cheminal engineer, an environmental engineer, a chemist or chemical technician”.

Frequently water is used in industry for several purposes which come from simple cleaning up to recooling industrial processes. That referred water often contains heavy metals or other toxic substances demanding to the environment and for that reason water needs to be recovered before its release in the
sewage system or on waterways. Water is a vital element practically in all sectors of industry. Motivated by economic reasons several companies started to lead management programs of their hydric resourcers implementing projects of water reuse, reduction of losts and racionalization of water use with expressive reduction of water consumption and also less release of effluents in the environment (Libânio, 2008).

According to Richter (2009), “Decantation is one of the oldest and simplest techniques of water impurities removal; it results from the action of gravity power over impurities easing their sedimentation at the bottom of the unit”. Decantation is a method of separating heterogeneous mixtures of two types: liquid + solid and immisible liquids. That is a physical technique because it is based on density difference between the components of the mixture (Leme, 2010).

**Function of the decantation**
The aim of the process is to remove solid particles or sludge that remains suspended for gravity action. Heavier dirt flocks remain deposited at the bottom of tanks, detached from water. Decantation tanks can be rectangular or circulars. Despite of being considered a simple process there are several types of systems. According to Cavalcanti (2009), the treatment and purification of water, environmental sanitation, hydric and industrial effluents treatment, for the application in water and effluents treatment, the process of decantation can or cannot be associated as an auxiliary process. Thus it is possible to find three types of decanters: conventional decanters, heavy-duty ones and centrifuge. The conventional decanters are more antique and more common ones and they demand on certain area of application. For them normally are applied mechanical systems of removal. Heavy-duty decanters are those that require sloping surfaces of decantation reducing the field of application and taking minor space (Filho; Branco, 2013).

In the water and effluents treatment processes some soluble solids are generated coming from the action of those matrices debugging. Those solids are called sludge. By being denser than water and by forming a heterogeneous mix sludge is a compound that can be separated by decantation. There are cases still in which the processes are applied in the beginning of the treatment by the removal of sand and charges of denser solids that come to be part of later treated mixture. That process helps to make the treatment simpler as well as it can protect the components of the stations against damages (Monte; Albuquerque, 2010).

To Richter (2009), “the main used element in decantation systems are sludge removals which depend on each process demands. The removal of sludge is undertaken by automatic or manual discharge systems”. The water is purified by the superior part of the equipment via “trough collector” and sent to decanting tank. “Decanting systems are those which consist on physical separation of heterogeneous mix of compounds with different densities. Under gravity action each compound is depositing in layers from denser to less dense until their total separation. The separation velocity directly depends on different density compounds (Filho; Branco, 2013).

Removals must meet the demand for processes with differentiated operating characteristics. They can be rectangular, circular, peripheral driven, central driven, and being characterized in accordance with the steps of the process or type of effluent that will result on solid sediments by weight. Decanting systems are applied on more diverse treatment systems of water and effluents, municipal or industrial, aiming principally separation solid/liquid, with or without preliminary steps of DBO/DQO removal to effluents with organic pollutants (Leme, 2010).

According to Cavalcanti (2009), “the function of decanters is to allow that flakes which already clarified water in flocculator can sediment”. The exit of water after sedimentation is close to surface, commonly for arranged chutes by forming several images where water flows at the superior edges, creating truly spillways edges.
Liquid and solid: the first step is to allow the mix to stand since solid part is denser; by time and gravity action, solid will be deposit in the bottom of the recipient. That step is called sedimentation. After decantation, that is, the careful separation of liquid part that is on the surface and transferring it other recipient. That can be done by siphoning that is the transference of liquid via siphon by starting the flow with suction (Monte; Albuquerque, 2010).

To Borges (2012), “the system of Decantation is applied in effluent treatment processes, aiming the removal of solid particles left suspended via sedimentation, that is, dirt flocks heavier than water decant and are deposit at the bottom of decanter”.

According to Cintra (2012), “the effluent to be clarified is inserted to tank through the system of central supply, since it allows the supply of decanter tank steadily and uniformly diminishing the effects of turbulence”.

![Figure 1 - Conventional Decanting process.
Source: Cintra, (2012).](image)

The removal of sludge (solids which sediment at the bottom of Decanter) is undertaken by automatic ou manual discharge systems. The separating purified water is taken from superior part of the equipment, through “trough collector” to decating tank.

**Types of decanters**

About it Leme (2010) assert that: the types of decanters are characterized as follows:

**By drain water:**
- Decanters of horizontal drain: the water drains in longitudinal direction with length as major dimension.
- Decanters of vertical drain: the water drains in upward movement from inferior part to surface of the tanks.

**By operating conditions:**
- Classic or conventional decanters: they are the ones in which sedimentation is processed only with already flocculated water.
- Decanters with solid contact: they promote simultaneously agitation, flocculation and decantation.
- Decanters with laminar drain: drains is undertaking by laminar regime.

**By operation they can be pooled:**
- Conventional (classic) – receive only flocculated water and process decantation only;
• By Solid contact or Flocculator – process flocculation and decant at the same tank (sludge blanket between 10 and 20% volume).

• By Laminar flow and Tubulars – use tubular elements or parallel plates to direct the flow.

Tubular decanters or heavy-duty are also technically and commercially called as lamellar or laminar decanters. Those decanters are an improvement of sedimentators with multiple bottoms developed as of 1915 based on Hazen’s experiences in 1904 when it was attested that the efficiency of sedimentation tank depends on its area and not of its depth (Carissimi, 2007).

In accordance with Cunha (2004), “lamellar decanters can be horizontal or vertical flows and what differ them from conventional decanters is the employment of plates and units inside them which diminish turbulence e reduce values”. According to Di Bernardo (1993), “can be circular, square, rectangular or hexagonal section doctors”. In addition, these decanters present efficiency results of superior turbidity removal over conventional decanters when compared under the same operational condition”.

By water management and the sustainability of its reuse

The water crisis has come and experts’ projections indicate that it will take long with even further worsening. It is therefore a setting of radical changes which requires a paradigm shift concerning to water use not only to residential users but also in account of its use in productive sector specially in industry.

In January 1997 Law n° 9.433/1997 went into effect known as Water Law. The legislative instrument instituted the Hydric Resources National Politic (PNRH) and also instituted the National System of Hydric Resources Management (SINGREH). According to Water Law, Hydric Resources National Politic has six foundations. Water is thought as a public good and a limited natural resource provided with economical value (Macêdo, 2014).

The Law provides that the hydric resources management must allow multiple uses of water in a decentralized and participative way counting with the interest of Public Authorities, users and with the communwelaths. It also determines that, in case of scarcity, water proprietary use is for humans and for provisioning of animals. Other foundation is that the hydrographic basin is the action of SINGREH and of Hydric Resources National Politic implementation (Brasil, 2002).

The second article of the Law presents the objectives of PNRH: to assure the availability of good quality water to current and future generations, to promote a rational and integrated use of hydric resources and the prevention and defence against hydrological events (rains, droughts, floods) on natural causes or in prevent of misuse of natural resources (Brasil, 2002).

According to Lima (2003), “Brazilian territory contains about 12% of whole planet fresh water. In total there are 200 thousand of local microbasins spread in 12 hydrographic regions, like São Francisco, Parana and Amazonica basins (the widest area in the world and 60% of that it is in Brazil) “. It is an enormous hydric potential able to provide a water volume for person of 19 times superior to minimum determined by United Nations (UN) – from 1,700 m³/s for inhabitant per year (Almeida, 2012).

Despite the abundance, Brazilian hydric resources are not inexhaustible. The access to water is not the same for all people on account of the geographic characteristics of each region and the changes in the river flow that take place due to climate variations during the year which affect the distribution.

In accordance with Rampazzo (2012), “conscious of the severity of hydric crisis, the civil construction industries are to have solutions that can effectively contribute to minimize the acute scarcity scenario and that allows the productive sector to keep on producing and generating jobs”. For that it is necessary that companies search for information and essential strategies for right management in the use of water, approaching the legal aspects and also fundamental questions related to catchment, effluents processing, rational use and reuse.

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The decreasing availability of water, the charge of its use, the growing demand for effluent treatment and the necessity of maintenance or improvements of water quality of receiving bodies elevate the sustainability of water and effluent management to a fist magnitude level to the proper sustainability of business of organizations mainly of those which have great dependance of that good increasingly more precious. To confront the challenges of efficient water management is necessary to adopt a water management which can be installed of short, middle and long term according to each industry characteristics (Vargas, 2012). To Salama (2012), “water is a natural resource with great ‘economic’, social and environmental value. It is essential to life and economy. Nevertheless, its value perception is still weak”. The use requires an advanced planning to guarantee its permanent availability that is to say to install its “sustainable use” because civil construction is a large consumer of water and on each work or reformation they use liters of water to aggregate mixture with cement, forming the concrete mass. According to CONAMA 430/11 resolution, effluents of any generating source can only be directly in the receiving bodies after a proper treatment and since it obeys to certain conditions, patterns and requirements. Currently the quality, the condition and the rules for each of water are regulated 357/05 resolution of CONAMA which determines criteria to each bodies of water class. That resolution was complemented by 430/11 which defined rules for input of effluents in watercourses. Thus already used water in industries or in residences are called effluents and its return to streams, rivers, lakes or dams, also must obey to severe rules, compiled recently in resolution of National Council of Environment (BRASIL, 2011).

**Sustainability in construction industries**

Nowadays the growth in the construction sector has providing a great demand for the use of concrete and other materials in construction industry. It is valid to point out that the progress in civil construction combined with environmental uncornern have been resulting in great damages to environment (L Du, KJ Folliard, D Trejo, 2002). The large consumption of water and solid/liquid wastes generated in machining centers of concrete are reasons that can entail in great environmental impacts and even on additional production costs. The problem is enlarged by the waste generated inside the balloon at the end of concrete services and in the quantity of water spent in the washing of trucks (Pinto, 2005). According to Cassa (2001), “it is estimated that the waste produced in construction activities are between 400 e 500 Kg/hab. Year. In general construction sector being responsible for 40% of waste generated in economy”.

Accordingly to Brazilian Association of Concreting Services Companies (ABESC) (2016), “with exception to water, concrete is considered the most consumed material in the world. Each year it is applied about 5,600 million cubic meters of concrete that are prepared with something around 2,400 million tonnes of cement and more than 1 million cubic meters of water”. He affirms that only in São Paulo region around 3,500m3 to 7,000m3 of residual concrete are generated. It is likely that with the huge consumption of water and the large amount of waste generated caused by big environmental impact, causing contamination on the ground and major damages to riverine environments. Current estimations point that the Earth hydrosphere contains the quantity of water around 1,386 milhões cubic kilometers. However 97,5% of that amount are saline waters and only 2,5% is fresh water. The majority of that fresh water (68,7%) is iced and is the permanent snow cover in Antarctica, in the Artic and mountain regions. Then 29,9% exist as fresh groundwaters. Only 0,26% of the total amount of Earth fresh water are concentrated in lakes, reservoirs and river systems (Curwell; Cooper, 1998). It is observed that a small
percentage of fresh water is available for consumption, the majority is of hard access, considering

treatment processes and transport costs up to human consumption.

Environmental impact of construction
According to Pinto (2005), “the enormous quantity of water produced for construction industry has been
frequently advertised because it has been causing serious urban, social and economical problems for too long. The management of that waste becomes more complicated as big it is the produced quantity”. Those data probably turn the civil construction industry the human activity with bigger impact over the environment. The set of processes that comes with construction end out to taking part of environmental important impact which degradates significantly the amount of life in urban environment. It is estimated that the construction chain of actions is responsible for consumption of 20 to 50% of all available resources, renewable and non-renewable (Curwell; Cooper, 1998).
The cement productive process has been pointed out as na impact generator not only in terms of
environment but also as social. Impacts related with factories surrounding comunities were
commonplace and some caused conflicts with their inhabitants, for either problems in natural
environment or for issues related to human health, such as: air, ground and soil contamination (Hoppen;
Portella; Joukoski; Trindade; Andreoli, 2006). At present, not all the cement factories lead to problems
since part of them have more and more trying to comply with law searching for a better sócio-
environmental responsability (Cassa, 2001).

The resource consumption in civil construction industry
According to Almeida (2012), “it is estimated that Brazilian civil construction industry consumes around
210 million tons of natural aggregates per year only for the production of concrete and mortans”. The
author also affirms that the volume of natural resources used by civil construction, many of them not
renewable, corresponds to at least the total yearly consumed for the whole society and that from the 40%
of energy consumed worldwide for civil construction, approximately 80% concentrate on processing,
production and transport of materials, some of them also release generators which provoke global
warming, acid rain and air pollution.

On sustainable management
Sustainable management arose from the need of companies to organize better their different ways to
interact in the environment. Thereby activities of managing the use of natural resources can be defined
by economic actions or policies, investments, institutional action and legal procedure with the aim of
maintaining or recover the quantity of resources and the social development (Rampazzo, 2012).
Currently it has been observed that companies which take care of their environmental liabilities and
have sustainable management policies and their costs reduced because as Salama affirms (2012):

- Consume less water by rational use;
- Consume less energy by reduction of waste;
- Use less raw material by racionalization of its use;
- Generate less leftovers and waste by suitable use of inputs;
- Reuse, recycle or sell waste when possible;
- Spend less with pollution control.

Since the costs are reduced, the companies raise their competitiviness because they can charge lower
prices preços menores. Furthermore, they conquer new consumers by showing their social
responsibility, once nowadays consumers are ever more conscious and well-informed concerning to environmental effects and about the productive processes ecologically healthy. They are to pay for more expensive partner brands which remark a positive attitude towards the environment (Hoppen; Portella; Joukoski; Trindade; Andreóli, 2006).

To Vargus (2012), “it is common to think that the industries are big polluters of the environment because they deal with natural resources, consume a lot of water and energy, they emit dust and toxic gases and they generate effluents and solid waste of hard treatment”.

The choice for sustainable management system normally is a gradual process. By opting for its implementation, however companies must not seek for financial benefits, economy of raw materials, efficiency on production and advertising should also estimate the risks of not managing their environmental aspects properly, like concerning to accidents, non-compliance with environmental legislation, failure to reach bank loans and other capital investments and market loss for inability to compete (Salama, 2012).

MATERIAL AND METHOD
The present research is characterized as a study case, essentially descriptive and qualitative. To Cervo, Bervian (2011), “this type of research takes place when facts and phenomena are registered, analyzed and correlated without manipulating them”.

The study was carried out at SUPERMIX CONCRETO S/A, where it was possible to observe, by the research, shortcomings in environmental field principally related to water use which is the first input to be used in organizations. The use of water requires an advanced planning to guarantee its permanent availability that is to say to implement its “sustainable use” so that civil construction is the large consumer and each new work or reformation use liters of water to mix the aggregates with cement composing the concrete mass (Salama, 2012).

The research tools used were: document analysis, interview and direct observation where collected and analyzed and data were tabulated and reviewed in several sectors of the company as: management, supervision, management of quality and production laboratory. Search forms were prepared to the research. By using the forms of documental analysis it was possible to collect documents like: reports, seals, certificates, proofs, minutes, estatutes, manuals among others in order to identify if the company reckons on standard documentation.

It was produced a script of seven questions to three employees of different hierarchical levels, one from strategic level, other from the tatic level and other one from operational level. Relating to direct observation a form was used on which each employee could answer by their personal analysis.

Rudio assures that (2011): “it is called research instrument what is used to collect data”, that is, it is effectively established what will be used in the development of the study to have information applicable to work.

By data collection it was possible to observe the result of the research and identify the shortcomings of the water treatment and reuse process in the company. According to Gil (2011), “The data collection helps to analyze point to point the facts and the phenomena which are taking place in a company being the start point for the elaboration and execution of a work”.

RESULTS AND DISCUSSION
Supermix Concreto S/A is a company which operates in the field of concrete engineering, more especificaly with mixture, transport and concrete release in central usine. It was founded in 1976, in Belo
Horizonte, currently with more than 7 million cubic meters of delivery capacity per year from more than 130 branches located in Brasil and in the state of Florida.

**Use of water from concrete central**
Water is one of the most used inputs in concrete work because it is necessary for cement hydration reactions as an agent that provides plasticity to concrete compounds of mixture. It is estimated a water demand of 160m³/day. Water used in that process comes from an artesian well properly bestowed by ADASA under the number 178 of Setember, 24th 2008.

**Figure 2 - Demonstration of water application in the central.**

**Reuse of water in concrete central**
Water reuse system by current running process provides economy of 40% to 50% of the quantity of water used in concrete dosage. It is equivalent to 1000 m³ of water a month, that is, 38m³ per day that are saved or left untouched from artesian well to the concrete dosage. The results observed consisted on conscious consume of water, at the most rigorous in terms of treatment and reuse of it. The company by adopting that process of water treatment and reuse will save between 70% to 80% of that reuse of water and economy on energy bill because the new technology which will be applied in the decantation processes will guarantee a better quality water and with lower consumption of electricity bringing economic, social and environment benefits, as it is seen on Figure 3 as follows:

**Figure 3 – Use of water.**
Source: Autores (2016).
**Water use process**
The wash of concrete mixer trucks produces contaminated water as input which cannot return to rivers. That wash takes place on the ballast which goes to decanter. The water from artesian well is used initially in concrete dosage where the raw material is mixed. The water which escapes out to channels which conduct to decanter.

![Figure 4.A - Dry truck.](image)
![Figure 4.B - Bate - ballast.](image)
![Figure 4.C - Truck loading area.](image)

**Figure 4** - Water use process.
Source: Autores, (2016).

**Water recycling process**
The water recycling process is done by decantation in which water "as flakes" passes to decanter, aiming flakes elimination by decantation. That step consists of solid – liquid separation by means of sedimentation of solid particles. The decanter tanks can be circular or rectangular. The effluents flow slowly through the decanter allowing solids to be suspended which have higher density than the surrounding liquid which sediment gradually at the bottom.
The recycling water is stored in a deposit, as seen in Figure 5.D which will be used later at concrete redosage, wash of trucks and wash of courtyard.

**Treatment and reuse of water research**

It was undertaken an interview with employees from estrategic, tatic and operational levels of Supermix Concreto S/A company in order to investigate the knowledge of them about the water economy management program and their interest concerning to improvement as shown in Figures below:
Figure 6 – Research on water treatment and its reuse.
Source: Authors, (2016).

Figure 6.A – Shows that only strategic and tatic levels know that the company has a water economy program. Figure 6.B – Shows that all levels know that the company undertakes some water treatment in its production which is related to decanter. Figure 6.C – Shows that all levels know that the company wants to adopt a natural resource management program. Figure 6.D – Shows that only the strategic and the tatic levels believe in the viability of the project. The operational level believes that there is not physical space to implement the project.

In the field research it was also applied a questionnaire of direct observation on which it was possible to collect information about all means used in the company concerning to water use, like it is shown in the chart of Figure 7:
Figure 7 – Water use.
Source: Authors, (2016).

Figure 7 – Shows that the use of water in the bathrooms is bad because they require maintenance. It is recommended that the company can adopt economic flushes and taps and keep their maintenance. The wash jet, doser and decanter are in regular state. The wash jet and the dosers require maintenance and the decanter needs to be broadened because it doesn’t have a suitable size for its demand. The tank is the only means which is good. It is suggested that the company continues to perform maintenance since it is a good means to water economy.

CONCLUSIONS
The research allowed the knowledge of how the water treatment and reuse by decantation takes place in industries of concrete. It was moted that water is one of the most used inputs in concrete work because it is necessary for cement hydration reactions as an agent that provides plasticity to concrete compounds of mixture. By adopting that treatment and reuse management process the company will save around 70% to 80% of water reuse and a saving in the energy bill since the new technology that is applied in the processes of decantation will guarantee a good quality water with low energy consumption bringing economic, social and environmental benefits. The water recycling process is done by decantation in which water “as flakes” passes to decanter, aiming flakes elimination by decantation. That step consists of solid – liquid separation by means of sedimentation of solid particles. The decanter tanks can be circular or rectangular. To elaborate this paper a technical visit was organized to Supermix Concreto S/A, and it was undertaken an interview with employees from estrategic, tactic and operational levels when it was possible to collect all necessary data to provide charts to understand it best.

By this research it was possible to understand that water is a key element in practically all sectors of industry.

ACKNOWLEDGEMENT
To Centro Universitário do Norte (UNINORTE), Supemix Concreto S/A, UFPA and to ITEGAM by the support to carry out this research.
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